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Scenarios of Five Federal Agencies (1991–95)

As Shaped by INFORMATION TECHNOLOGY

Henry H. Hitchcock
Lisa Heinz
Joseph F. Coates

A Report to the
Federal Government Information Technology Project,
The Office of Technology Assessment
U.S. Congress

This contractor document was prepared by an outside contractor as an input to an ongoing OTA assessment. It does not necessarily reflect the analytical findings of OTA, the Advisory Panel, or the Technology Assessment Board.

Contract No. 433-0125 J952-52 JUNE 21, 1985

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PREFACE

The Congressional Office of Technology Assessment, in discharging its statutory responsibilities for early warning to the Congress, is conducting a study entitled Federal Government Information Technology. In this project, OTA is analyzing how computers, telecommunications, and other information technologies which could be available for Federal use within the next decade could affect the federal government, especially in the areas of privacy, security and civil liberties.

The present report is on one of seventeen small projects conducted as background and preliminary input to the overall report. The appended list of parallel projects should assist the reader in putting this report into context.

In attempting to anticipate the consequences of information technology for several federal agencies it seemed sensible to engage those agencies in some way or another with this project. At the same time it was essential that the agencies have no responsibility for the results and hence, would feel less constrained or inhibited in assisting us. By agreement with OTA, a group of candidate agencies was identified, representing a wide range of government functions, activities and sizes. We agreed to only do scenarios for agencies that were willing to aid us by organizing a workshop and agreeing to critique our report. As a further condition we agreed with OTA that our scenarios would do no harm in the sense that they were not intended to become instruments for berating the agencies, for exposing or over-dramatizing weaknesses, or representing potential worst case futures as likely. Those ground rules were implemented as described in the body of the report.

We wish to acknowledge the large number of people who helped us. Exhibit 7 notes each agency's principal point of contact and those who participated in our workshops. In addition, other people were helpful in collecting material, responding to specific questions, or reviewing our reports. To each of them we express our gratitude for providing a sense of organizational reality which could not otherwise have been available to us. On the other hand, none of the people acknowledged is in any way responsible for the structure, organization or content of the material in this report. It would be reprehensible for us to impute any such responsibility to anyone assisting us. It should be clear to any reader that the scenarios contain material which by their nature show disturbances, disruptions and developments in the agencies which they and we would certainly hope never occur. Furthermore, many of them show organizational developments which are already outside the scope of present organizational plans and which, to a large extent, depend upon external events, the likelihood of which we, not the agencies or OTA, have built into the scenarios.

At OTA, Fred Wood, Project Director, and Jim Dray, Project Officer responsible for this project, have been demanding and helpful clients. They, like our workshop participants, cannot be held responsible for the content of these scenarios nor for the implicit analysis in them nor for the explicit analysis in the surrounding chapters.

To the reviewers of this material on the OTA staff and elsewhere, both known and unknown to us, we express our appreciation for their help.

At J. F. Coates, Inc., Jennifer Jarratt helped the study team with review and comments.

The production of this report was the responsibility of Beverly Goldberg, assisted by Susan Nelson, Diana Clark and Elijah Merritt.

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CHAPTER I

INTRODUCTION

The technologies of telecommunications, computers, and information manipulation are spreading across government, corporate and private America at a breathtaking pace. These new technologies hold the unique promise of being able to virtually guarantee an improvement in productivity, efficiency, and effectiveness, whether introduced in the farm, the small business, the national or multinational corporation or the government agency.

The implicit or explicit awareness of that virtual guarantee of enhanced performance is the underlying basis for the rapid spread of the technologies. The effects of the technologies, however, cannot be limited to improving current activities. The forces are so powerful and universal that they reshape the very activities which they come into play to enhance. In turn, they reshape relationships, functions, power flow and activities within the organization and with groups and individuals external to the organization.

Telecommunications and computers have reached the point in their technological and economic development and applications that a new terminology is emerging. The terminology throws them together under the more comprehensive rubric "information technology," or to use the term coined by Nora and Minc for the president of France, "telematics." The nomenclature is more than a mere convenience. It reflects the structural changes in marketing, use, and regulation of these technologies. Telecommunications technologies, primarily radio and TV broadcast, cable and telephony were regulated technologies. In contrast computers were developed in an unregulated, competitive open market. Over the past decade, the technologies have grown together in a technical sense to the point where it is often difficult to distinguish between telecommunications and computational devices. The problem becomes even more difficult with complex systems such as local area networks. Perhaps the most straightforward illustration of this melding and complexity of the new technologies is represented in the attempt to define a telephone precisely and comprehensively. Most national magazines and any business publication will tout a score of different telephones by different manufacturers with different services, functions, and characteristics, most of which were simply not available before the microprocessor was married to the telephone.

Information technology is a core technology in the sense that it is limitless in the number of areas to which it can be applied. Each new application is likely to have its own effects. Information technology now goes beyond mere marginal improvements in efficiency or effectiveness. Instead, it offers great improvements in virtually any area to which it is introduced. However, the introduction of new information technology always occurs in the common and traditional hope of enhanced individual or organizational efficiency and effectiveness. Microeconomics dominates the choices about the introduction of new technology whether in a large or small business, federal agency or a household. Yet by virtue of being a core technology, many of its most important effects will elude the microeconomic criteria of first introduction and only come to full flower when that technology is cheap, familiar, commonplace, widely available, and well understood. The purpose of this study is to explore information technologies now being widely adopted throughout the federal government with a view to defining how those technologies may affect government when they are widely available, well understood and cheap to use.

The Approach

The approach taken in this study is to define the time period of intent as the next ten years, recognizing that the technologies are being adopted at varying rates by different agencies. We assume that the reader is familiar with the main technologies likely to be prominent a decade from now. There is extensive literature about their characteristics and the varying pace at which they are developing. To circumvent the need for creating an encyclopedia of telematics technologies, we merely note the technologies briefly and emphasize the capabilities which they will bring into play as they become more commonplace throughout government.

From a conceptual point of view, we see capabilities as the route to understanding how the technologies will affect any system into which they are introduced. Many capabilities are available through alternative technologies. For example, high density communication can be had through microwave, fiber optics, coaxial cable and satellites. The details of those alternatives are extremely important in some circumstances, but for present purposes, we need only note the capabilities that those alternatives separately or together may provide.

Having defined the capabilities, the next stage is to look at the system which they will influence — the agencies of the executive branch of the federal government. Little more than passing attention will be given to the Judiciary, and only incidental note will be taken of the effects of telecommunications and computers on the Congress; both of these are being examined in parallel projects. No attention will be given to international governmental relationships such as connections to the United Nations or the Organization of American States, nor will attention be given to ties to state, local, and regional government, except insofar as that illustrates an unfolding capability or is critical to a likely consequence. The paper concentrates on the Executive Branch. In terms of that concentration, it gives little notice to the Department of Defense and its subsidiary organizations; not because they are not important, but rather because they are so important that they merit separate, independent treatment beyond the reach of this project.

This report concentrates on the impacts of telecommunications and computer technology over the next ten years on the civil sector of the federal government.

To draw all these threads together in a way which gives more effective imagery of the impacts, scenarios are presented of how the telematics technologies may affect five federal agencies with different missions, functions, staff and size. These scenarios were prepared with the active cooperation of the agencies. Following the scenarios a section deals with planning for information technology in the federal government. That section highlights the special characteristics of information technology which distinguishes it from other aspects of federal planning. The section emphasizes the built-in structural difficulties in the present organization of government for achieving long-range information technology planning and the even greater difficulty of building in appropriate public access, and safeguarding civil rights and civil liberties while striving for efficiency and effectiveness in government.

Finally, some general conclusions and recommendations are drawn with regard to more effectively managing the infusion of information technologies into the federal government.

The Scenarios

Two questions crucial to thinking about or planning for the information future are:

- How will the technologies affect specific federal agencies, since each is a different operating entity?
- How does one grasp the effects of the individual technologies and capabilities when they come together to create their total integrated effects?

The approach for dealing with those two questions is to create scenarios -- complex, integrated images of five federal agencies in 1991-1995.

Scenarios are a widely used tool in corporate and organizational planning. Taking the basic definition of Kahn and Weiner from their 1967 book, The Year 2000, a scenario is "a hypothetical sequence of events constructed for the purpose of focusing attention on causal processes and decision points." A more up-to-the-minute definition reflecting current practice is put forward by Warfield and his associates, "A scenario is a narrative description of a very possible state of affairs or development over time. It can be very useful to communicate speculative thoughts about future developments, to elicit discussion and feedback, and to stimulate the imagination.

Scenarios generally are based on qualitative expert information, but may include quantitative information as well."

The scenario is a technique to deal with a core problem of a study of the future. The individual trends do not automatically come together to create useful images of the future applicable to planning. A primary purpose of the scenario is to create these holistic, integrated images of how the future may evolve. Those images, in turn, inform planning, are a testbed for ideas, or are the stimulus for new development or further research.

How the Scenarios Were Constructed

To make the scenarios credible to those who would use them, it was decided to conduct workshops in agencies selected for scenario development. A broad range of personnel in each workshop provided realistic background material and some stimulating concepts for the scenarios.

The selection of the agencies was governed by the desire to cover a broad range of governmental functions — agencies which are primarily data collectors or which disperse information; those which have sweeping contact with the public; those which regulate; those which perform some service function; or those which are oriented toward research. The second and equally important criterion was that the agency would itself be willing to cooperate in at least two ways. First, in organizing the workshop; and second, in reviewing working draft material.

On the basis of these criteria, five agencies were selected:

- The National Oceanic and Atmospheric Administration
- The Bureau of the Census
- The Internal Revenue Service
- The Environmental Protection Agency
- The Social Security Administration

Agency workshops as described in Exhibit 1 contributed to the design of the scenarios.

Exhibit 1
THE AGENCY WORKSHOPS

The workshops, which typically ran three hours, ranged from six to twenty people and followed the following rough format.

- Introduction to the OTA project

- A review of conceptual activities and working concepts to date. This consisted of a distribution of five handouts, which are Exhibits 2, 3, 4, 5, and 6 of this report. Those Exhibits were then used in a twenty minute briefing. Exhibits 2 and 3 oriented the participants to the technological assumptions, and the capabilities thought to be critical coming out of those new technologies. Then, to complement the technological side, the general characteristics of bureaucracies and the range of activities of federal agencies in general were reviewed in Exhibits 4,5 and 6.

- The exercise proper. The workshop exercises were constructed to be highly interactive and to promote a great amount of discussion and cross talk among the participants. Typically, they began with a round robin of discussion after a few minutes of private deliberation on the question:

  "What will be the major impacts of the emerging information technologies on the mission, function or purpose of your agency?"

- The second question which was frequently asked involved dividing the group into pairs or triplets and having them work for ten or fifteen minutes on how information technology might affect the specific topics in Exhibits 5 and 6. The duets or triplets then reported their judgments to the plenary group where further discussion and elaboration occurred.

- In some cases the groups were asked to focus sharply on outcomes by answering a question such as the following:

  It is 1995 and you individually are giving Congressional testimony to your oversight Committee. We would like you to complete the following sentence: "After ten years of extensive and expanded use of information technologies, I wish to report to you today that the principal consequence has been ..."

- Similar exercises were tried in various forms and formats. The material, however, was all taken as raw suggestive input into the scenario development.

Exhibit 2

KEY CLUSTERS OF TELEMATICS TECHNOLOGIES

Mainframe computers and associated information systems
- Central data banks
- Artificial intelligence, expert systems, pattern recognition
- CAD/CAM, robotics
- VLSI, VHSIC

Microcomputers and word processors
- Computer graphics
- Spreadsheets
- Software packages

Networking technologies
- LANs
- PBX
- E-Mail
- Fax
- Voice mail

Telecommunications technologies
- 800 numbers
- Packet switching
- Fiber optics
- Cable, one- and two-way
- Communication satellites
- Videotex
- Teletext
- Electronic message systems
- Teleconferencing
- Computer conferencing

Reprography and printing
- Printing on demand
- Xerography
- Facsimile
- Holography

Peripherals
- Cellular telephones
- Encryption
- Voice activation
- VCR
- Audio cassettes
- Pattern recognition
- Protocol converters
- Voice recognition
- Video disks
- Speech compression

Exhibit 3

THE NEW OR NEWLY IMPORTANT CAPABILITIES OF INFORMATION TECHNOLOGIES

- Networking -- Interdependencies
- Control Over Time and Space
- Higher Productivity/Amplify Human Cognitive Functions
- New Extensions of Human Action
- New Levels of Efficiency and Productivity/Energy, Materials Conserving
- New Power to Obscure
- New Power to Centralize and Decentralize
- Blurring of Organizational Distinctions
- Promotion of Monitoring, Evaluation, and Simulation
- Erosion of Hierarchical Relationships
- Shifting Power
- Shifting Authority
- Integration
- New Mischief/Vulnerabilities
- Promote Autonomy/Dependency

Exhibit 4

CHARACTERISTICS OF A BUREAUCRACY

1. HIERARCHICAL STRUCTURE
   - —FORMAL CHAIN OF COMMAND

2. FORMAL COMMUNICATIONS NETWORKS
   - —INTERNAL REPORTING SYSTEMS
   - —TENDENCY TOWARD SECRECY

3. DIVISION OF LABOR
   - —ABLE TO HOUSE AND MARSHAL WIDE VARIETY OF EXPERTISE
   - —SPECIFICATION OF AUTHORITY FOR EVERY POSITION AND UNIT
   - —IMPERSONALITY IN EXECUTING TASKS

4. PREDICTABLE BEHAVIOR
   - —EXTENSIVE SYSTEMS OF FORMAL RULES, PROCEDURES, AND REGULATIONS

5. LIMITED FLEXIBLITY
   - —PRIMARILY AS INCREMENTAL RESPONSE TO EXTERNAL CHANGES
   - —OVERRIDING CONCERN WITH INSTITUTIONAL MAINTENANCE

6. STAFFED BY PEOPLE
   - —INFORMAL AND PERSONAL COMMUNICATIONS NETWORKS
   - —INFORMAL STRUCTURES OF AUTHORITY
   - —INTENSIVE PERSONAL LOYALTY AND INVOLVEMENT, ESPECIALLY AMONG HIGHEST RANKING OFFICIALS

Sources: Robert C. Fried, Performance in American Bureaucracy. Boston: Little Brown and Co, 1976. pp. 29-30.

Anthony Downs, Inside Bureaucracy. Boston: Little Brown and Co., 1967, p. 265.

Joseph Coates, "What is a Public Policy Issue?", Interdisciplinary Science Review Vol. 4, No. 1, 1979, p. 27

Exhibit 5

THINGS EXECUTIVE AGENCIES DO

Goal Seeker

- plan
- prepare or respond to legislation
- develop, analyze, and evaluate policies and programs
- make decisions
- create and maintain decision support systems

Employer

- hire, fire, train, promote, supervise, and reward personnel
- work with unions and other labor organizations
- enforce civil rights/EEO regulations
- adjudicate employee appeals

Housekeeper

- ensure health and safety of employees
- protect the security of personnel and operations
- maintain facilities, real property, and equipment
- provide mail, reproduction, and other support services
- provide supplies - office, building, transportation, etc.

Public Bureaucracy

- develop and maintain information and communication systems
- prepare and implement budget
- define, reclassify, and eliminate job descriptions
- coordinate with other agencies
- work with state, local, and international governments
- respond to Congressional requests, oversight, initiatives
- follow President on policy, budget, and other matters
- provide information and access to constituents, clients, and public

Watchdog

- eliminate fraud, waste, and other abuses (inspector general)
- audit budget, procurement, personnel, and other functions
- maintain and enforce administrative procedures and ethics codes
- monitor and ensure quality of agency products or services
- adjudicate contract appeals

Exhibit 6

THINGS MANY EXECUTIVE AGENCIES DO

Regulator

- set standards
- license
- investigate/inspect
- enforce compliance
- adjudicate complaints
- litigate

Buyer

- let and administer grants and contracts
- procure supplies and equipment
- acquire major systems
- buy facilities/real property
- make payments

Information Source

- prepare and present statistics
- publish reports, magazines, and other publications
- conduct or support research, development, testing, and evaluation
- market program, information, and other products
- offer information and assistance to consumers and other publics

Information Seeker

- collect information -- surveys, required reporting
- run public participation programs
- hold public hearings or seek public comments
- seek the counsel of advisory panels or commissions

After draft scenarios were produced, they were returned to the contact in the agency. Comments, criticisms, and supplementary remarks were solicited. Modified scenarios were then rendered to OTA.

The scenarios themselves, which follow immediately, were constructed in the following way:

A hypothetical new Joint Congressional Committee is put forward. A new bit of legislation is framed dealing with the impacts of information technology. Out of that hypothetical legislation certain requirements are defined, notably for a biannual report on the consequences of information technology for each agency. The particular categories to be covered by the legislation are noted, and the agency scenarios are in the form of the first report under that bill. The reason for the choice of format is that reports to the Congress are a familiar medium which allows the material to be organized in common categories -- mission, workforce, public outreach, decisionmaking, etc.

What Follows

What follows is the introduction to the scenarios in the form of a statement of hypothetical federal legislation passed in 1989. Then scenarios for each of the federal agencies are presented as first responses to the biannual report required by that legislation.

The Hypothetical Legislation

The 101st Congress of the United States in 1989 established the Joint Committee on Information Technology and Government. The first major bill came out of the new legislative committee in mid-term in 1990. The bill requires a biannual report from each agency of the Executive Branch on the impacts of information technology on the agency, its mission, structure, function, organization, and effectiveness. Particular attention to security, privacy, and public information is required.

The accompanying five documents are the first major reports mandated for delivery January 15, 1991. They are assembled here as a basis for legislative hearings scheduled for the Fall of 1991. The act, Public Law 101-16, often referred to as the Citizens' Security

Act, goes well beyond the central concerns of the Joint Committee for privacy, security, and confidentiality. As framed, the public law is a major vehicle for the assessment of the impacts of information technology on the internal relations and the working of government, and its interactions with individual citizens, business, other kinds of domestic organizations, international trade and commerce, international organizations, and foreign governments.

The Citizens' Security Act, while not specifying a formula for the biannual reports, does require that they cover certain topics:

- The mission of the organization, its organization and structure.
- Labor and employment.
- Physical assets, housekeeping and facilities.
- Regulatory activities.
- Procurement, contracting, purchasing.
- Information collection and processing.
- Information storage, handling, access, and dissemination.
- Executive agency coordination, advice, and liaison.
- Congressional oversight.
- Specific changes, alterations, modifications, improvements, and deteriorations in structure, function, and performance, of organizations not otherwise noted.
- Anticipated developments and their consequences over the next five years.
- Planning, implementation, and evaluation of policies, programs, and projects.

The reports are to be prepared in a format which will permit their ready and convenient use by the Fednet Videotext-Teletex network, which provides for citizen access to and interaction with federal communications network on an ad lib basis. Specifically, the Citizens' Security Act reports will be aired for no less than six hours a day from February 1st to April 30th, 1991. They will also be available for examination, review, discussion, and evaluation on Federal Compunet, the computer conferencing network.*

Following are summaries of five of the first major agency reports under the Citizens' Security Act drawn from full reports produced by the:

- o National Oceanic and Atmospheric Administration
- o Bureau of the Census
- o Internal Revenue Service
- o Environmental Protection Agency
- o Social Security Administration.

NOTICE

The scenarios which follow are totally and solely the responsibility of the authors and should in no way be interpreted as having any official endorsement or unofficial approval by the subject agencies or by any of the workshop participants.

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* The reader should have no difficulty in recognizing that Fednet, Videotext-Teletex and Federal Compunet do not yet exist. In the scenarios which follow the situation is more complex and the reader is therefore advised to pay close attention to the endnotes in each section, which sort out what are current activities, organizations and units in government from those which are hypothesized for purposes of the scenarios.

CHAPTER II

BIANNUAL REPORT TO CONGRESS ON INFORMATION TECHNOLOGY AND GOVERNMENT
NATIONAL OCEANIC AND ATMOSPHERIC AGENCY
January 15, 1991

HIGHLIGHTS

NOAA in 1991 is an independent agency, although it retains the 1985 internal line offices (LOs) under a central administration. The five LOs are the National Weather Service (NWS), National Environmental Satellite, Data and Information Service (NESDIS), National Marine Fisheries Service (NMFS), National Ocean Service (NOS), and Oceanic and Atmospheric Research (OAR). NOAA administration services and coordinates the work of the LOs.

As in 1985, NOAA in 1991 is both a science and service agency. Transfer of services to the private sector has proceeded haltingly; late 1980s' attempts to privatize major pieces of information collection and delivery were marked with as many failures as successes. NOAA's streamlined focus is on comprehensive global data collection and verification. The private sector offers many new products based on special value added processing, delivery, and applications of NOAA data systems.

While NOAA's structure and functions reflect federal political and economic priorities, this report to Congress focuses on the substantial changes which have been driven by information technologies since the late 1970s. The biggest qualitative changes have been in information collection and dissemination; consequently this scenario focuses on the LOs most involved in these activities, NWS, NESDIS, and, increasingly, NMFS.

- NOAA's information products are delivered faster and more accurately to more users around the world than ever before. The ease and low cost of tailoring data to the specific needs of each user has revolutionized the usefulness and scale of use of NOAA data. The greatest innovations have come in the NWS, where although much value-added and routine data processing has been left to the private sector the number of individual and private real-time direct users of improved NWS data has more than tripled over the past five years.

- A major initiative to create a NOAA-wide data access system transparent to the computer-equipped user is progressing toward a system which will access all of NOAA's databases. The linchpin of the system is dedicated Comsat high speed data links.
- NOAA has expanded its role in federal data storage and verification, setting standards for and certification of other private, state, and foreign databases, and in tracking the location and resources of other data centers.
- NOAA's modeling of large systems and large numerical operations, central to its services and research, are the best in the world. Its supercomputers attract leading researchers and contributed to NOAA's international scientific prominence.
- In coastal zone and fisheries management much oversight and management responsibility has passed to individual states, but on the strength of its broad information and expertise base NOAA acts as standard-setter, arbitrator, scientific authority, and technical adviser on science, resource management, and data handling.
- Nowcasting has grown rapidly with the availability of real-time data gathering instruments and information delivery systems at national, regional, and local levels.
- Twenty day weather forecasting is routinely available on the contiguous 48 states with accuracy approaching that of six-day forecasts in 1985. With improved global data collection and modeling NWS forecasts climate two months ahead; in 1985 three weeks was the horizon of the rudimentary computer models.
- Thousands of automated, multivariable data collection platforms, linked in an integrated, satellite-coordinated network, have greatly expanded NOAA's comprehensive data collection. These sensors provide not only real-time environmental, weather, and resource monitoring but have been the foundation of micrometeorological analysis. In total NOAA agencies manage 363,000

automatic weather and environmental sensors in the U.S. and elsewhere on the globe, and advise 63 countries with 400,000 similar sensor sites.

- The vantage point of space is an increasingly important arena for NOAA. Satellites, space platforms, and space shuttle-based observations provide over 35% of the digital data volume, compared to under 10% in 1985.
- With NOAA's focus on data gathering and analysis, much of routine data interpretation and value-added services has passed to the private sector. Supported by NOAA technology transfer, industry and public interest organizations have assumed the lead in specialized environmental and weather data interpretation.
- The 200-mile Exclusive Economic Zone (EEZ), the least-known and fastest growing economic resource of the U.S., has been the fastest growing geographic focus for NOAA's unique integrated research and resource management.

INFORMATION TECHNOLOGIES IN NOAA: 1985

Mission

NOAA's integrated mission was the same in 1985 as it is now. It combines research, information gathering and dissemination, and services, and regulation. It spans weather, atmosphere, outer space, the ocean surface and depths, fisheries, and coasts, rivers, estuaries, and wetlands. NOAA's science and services are information-intensive.

In 1985 NOAA was still an administration within the Department of Commerce. The LOs operated fairly independently, although collaborating successfully on formal international projects and informal enterprises like El Nino. NWS dominated the five LOs in terms of budget and manpower.

Information Collection and Analysis

The global data collection network of NOAA spans satellites, data buoys, ships and planes, balloons, remote sensors, human observers, and secondary data from other federal agencies and other nations.

NOAA operated two major satellite series to gather and transmit meteorological and environmental data, the geostationary GOES and polar TIROS-N series. In addition, NOAA participated in other satellite operations, including Landsat and SARSAT search and rescue. The polar satellites imaged the earth's surface in visible and infrared wavelengths, and monitored clouds, atmospheric temperature, ozone, and vertical moisture profiles.

NOAA maintained two operational geostationary satellites of the GOES series. In 1984, however, only GOES-6 was functioning. Other nations (Japan, India, the USSR, and the European Space Agency) operated similar satellites to provide comprehensive coverage of the earth. In addition to imaging and monitoring the earth, ocean, and atmosphere, the GOES satellites served as relays for remote observations from ships, remote weather stations, ocean buoys, hydrological sensors, seismic sea sensors, etc. The GOES data collection system collected environmental information from more than 10,000 fixed or free-floating data collection platforms every six hours and relayed it to NOAA command and data acquisition stations. The data collection and platform location system could interrogate or locate up to 459 platforms within view of the satellite at any given time.[1]* An NWS GOES Data Distribution System entered operational phase in 1985 to distribute hydrometeorological data to NWS Field Offices. NOAA operated the necessary ground stations, telemetry, and data processing and analysis equipment.

The weather analysis and forecasting capabilities of NWS were based on three main computer systems — the supercomputer modeling and forecasting systems; a front-end system to process the vast amounts of incoming data; and an additional computerized network for communications among weather offices. In 1985 the Joint Numerical Weather Prediction Unit (JNWPU) of NWS used a Control Data Corporation Cyber 205 for modeling, attached to three National Advanced Systems 9040s for front-end processing. An IBM 4341 absorbed raw observation data: each day it received 14,000 reports from surface stations, 2500 upper air, 4100 reports from ships and aircraft, 2500 satellite measurements, 500 radar reports, and 100 satellite photographs.[2]

The early Automation of Field Operations and Services (AFOS) system linked most of the 52 Weather Service Forecast Offices and many of the 240 Weather Service Offices.[3] Data input did not include more than a bare minimum of satellite and radar data; the offices that were in the network received the bulk of their data channeled through the NMC.

Information Dissemination

NOAA was just beginning to make its vast amount of data directly available in databases to users and the public. The National Environmental Data Referral Service (NEDRES) brought together data from many federal agencies. Three tiers of users — occasional users, active users, and member organizations[4] — were differentiated by the extent of their use and what data they could enter into the database.

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[1] References are at the back of the scenario. These references give the source for, the logic behind, or the explanation of the specific illustrations, projections, or assumptions included in this scenario.

- A half-billion phone calls a year were made to NWS recorded weather forecasts.
- Nearly three million people each week watched the 24-hour Weather Channel on cable, averaging one-half hour a day.[5]
- Increasing effort was being put into specialized monitoring and warning systems, such as the Integrated Flood Observation and Warning System (IFLOWS).[6]
- National Weather Radio and NOAA Weather Wire Service broadcast free, continuous weather information and warnings.

Combined meteorological data were used in disaster warnings, frost warnings, timing harvests, flood warnings, water supply management, hydroelectric power scheduling, locating ocean currents for navigation, upwelling for fisheries, ice and snow mapping, etc.

Many private companies provided weather information services — real-time access, unusual analysis presentation formats, and data — to professional meteorologists and business users, through dedicated telephones lines to a local satellite downlink, or through personal computers.

With the advent of new AFOS and radar (NEXRAD) technologies, NOAA was laying in place long-range plans to close 90% of weather stations, leaving 100 highly automated and sophisticated stations each covering weather in a 30-county radius. The move would cut in half the number of NWS employees. This reduction was resisted by Congress and public.

The 1985 charting system combined manual and semiautomated procedures. The current Nautical Charting Automated Information System was just being implemented.[7] The database was being laid in place for river forecasting.

Coordination

NOAA's crosscutting, reliable data and scientific expertise were utilized by many federal agencies and state and local governments. Major user agencies and industries -- agriculture, transportation, fisheries, construction, oil and gas — worked with NOAA to improve weather data collection and analysis for their special needs.

Because of the lack of computer and even telecommunications links to user agencies or industries, coordination of NOAA data and services with user applications was slow and coarse. The largest interaction was with the Federal Aviation Administration (FAA) and the Federal Emergency Management Agency (FEMA) on weather data.

Congressional oversight of NOAA was close and detailed because of the close ties between individual states and NOAA operations, especially in weather and coastal zone management. Through Congress, states' interests strongly influenced NOAA policy and planning.

Research

Ten environmental research labs conducted mission-oriented basic research in climate; weather observation, prediction, and modification; air quality; hydrology; solar-terrestrial physics; and marine observation and resource assessment.[8] NMFS operated more than 20 fisheries labs around the U.S. NOAA lab research was supplemented by cooperative institutes and contracts and grants to universities.

Research was supported with a range of technologies (i.e., micros, minis, mainframes, LANs, PBXs, file servers) to develop local databases and administrative systems. The Geophysical Fluid Dynamics Laboratory at Princeton had two CDC Cyber 205s. These supercomputers were invaluable not only in modeling large weather and environmental systems for forecasts but in research on understanding the forces acting in weather and the global environment.

Regulation/Resource Management

Major resource management and oversight responsbilities for NOAA are fisheries and and coastal zone. NOAA also has the responsibility for conservation of marine mammals and endangered marine species. The emphasis was on assisting states to administer coordinated resource protection and management plans. NMFS headquarters and regional centers used a complex system of networked microprocessors updated mainframes (Burroughs CPUs) in fisheries resource management. Plans in 1985 were geared towards linking state, NOAA, and other databases to improvement resource management.

Audit and Monitoring

NOAA generates large volumes of information vital to the national economy. Accurate and timely storm and flood forecasts translate into lives and dollars saved. Major industries -- utilities, mining, construction, agriculture, fishing, recreation, and transportation -- base their planning on NOAA information. NOAA must audit the quality of analysis going out to users and primary data coming in. In 1985 this was done mostly by manually checking preliminary analysis against updated observations ranging from a few minutes to a day old.

Personnel

NOAA had approximately 15,000 employees in 1985, dispersed around the nation in labs, service centers, and NWS offices. The first personnel impacts of automation had begun to be felt by the clerical workers and technical staff in such traditionally manual labor-intensive areas as cartography and surveying.

Through the latter half of the 1980s, routine personnel functions shifted to the Regional Administrative Service Centers under the Department of Commerce. Like other federal science agencies, NOAA was having difficulty keeping its traditionally first-rate scientists. although many were still attracted to the unique large systems research available only at NOAA.

In 1984 in the Office of Oceanography and Marine Services each terminal was shared by three workers on average. In some programs, the ratio was as low as one for five or six workers.[9]

Procurement/Support Services

Budget and finance work was still done extensively on stand-alone microcomputers and word processors in 1985. The first LANs were being laid in place to link in-house microcomputers and word processors. The main effects of this first round of automation were improved speed and accuracy of budget work. They also allowed cross-cutting analysis by function or organization, or of topics such as travel or equipment. The Financial Information Management and Accounting System was the most complete of the administrative databases.[10]

Security was limited to the use of passwords for access to files. Essentially all NOAA data was considered not sensitive or classified. The major exception was fisheries data; the Fishery Information Network (FIN) was just being set up and the first rings of security of access were being laid in place.[11]

With five relatively independent LOs and personnel and facilities spread around the nation, NOAA internal networking systems lagged many other federal agencies. In 1985 only a few LANs and PBXs were set up; NOAA began linking through existing value-added networks such as TeleNet to bridge the slow transition to its own internal networks. The first multifunction workstations were being introduced.

A variety of partial administrative databases were organized on a number of computer systems. The bulk were on three computers, a Univac 1100/82, the NOAA-wide timesharing system, and a CDC Cyber 750. No NOAA-wide data standardization or information protection policies were in place.

Planning

In addition to central NOAA Policy and Planning each LO had an administratively independent planning office. Coordination among them and with the Department of Commerce was conventional and piecemeal. Information system planning in each LO was essentially independent. Stand-alone word processors and personal computers had improved the efficiency of planners over the late 1970s. Electronic mail was available within but not between the different planning offices.

INFORMATION TECHNOLOGIES AT NOAA: 1991

This section highlights how information technologies have shaped the independent NOAA of 1991. It begins with the mission, then discusses information collection, analysis, and dissemination by NOAA; research; regulation and resource management; and finally the administrative functions of auditing and monitoring, personnel, procurement and support, and planning.

There has been no significant change in structure at NOAA since its became an independent agency in 1989. Interaction among LOs has increased with the spread of information technologies and challenging integrated missions, even though NOAA administration has not expanded.

Mission

NOAA's mission in 1991 is unchanged since the agency's inception — to be the nation's leader for integrated knowledge and management of the oceans and atmosphere. Within that broad mission, however, the focus has changed, driven by advances in data gathering, analysis, and dissemination. Data collection and verification has expanded and large integrated systems work is more important, while the private sector has increased its role in specialized data analysis and delivery. The use of information technologies has advanced more rapidly than planned due to the increasing demand for comprehensive and up-to-date information about the environment, resources, and climate.

NOAA has focused on the analysis of large systems — climate, weather, the ocean, atmosphere, and hydrological and biological systems. Cross-LO interdisciplinary assessments of multiple ocean resource use have responded to increasing marine resource competition for fisheries, minerals development, energy, coastal zone development, environmental protection, and waste disposal. Information technologies have made possible integrated regional assessments for ocean and coastal resource management. The speed and accuracy of weather forecasts has improved. Improved hydrology modeling and river information supports integrated water resource management. Weather information and short-term forecasts and nowcasts are available to commercial users and the public in real time.

The international activities of NOAA have expanded considerably through working arrangements with other nations as well as formal projects such as the World Climate Research Program and the International Geosphere/Biosphere Programme. Information gathering is more global, through a network of satellites, remote automated stations, and data exchange with other nations and organizations. Many of NOAA's information analysis and products, however, are increasingly restricted to U.S. territory because of national economic and security concerns, especially in weather, geodesy, and seabed mapping.

NOAA has maintained its high international reputation in research on global scale atmosphere, marine environment, and climate. NOAA is also a scientific leader in computer modeling, graphic displays, and real-time computer networks. Many of NOAA's products, developed to advance its weather forecasting mission, have been further enhanced in the private sector through NOAA technology transfer.

With the continued movement of services to the private sector, NOAA has focused on its critical federal role on assuring reliable and comprehensive reference information. NOAA has become a nexus for information about the marine and coastal environment, the atmosphere, and global physical and biological circulation. From this base, is has also had an increasing role in setting standards for private sector weather services.

Information Collection and Analysis

The greatest changes in information collection and analysis have been in upgraded modeling and forecasting; remote, real-time observations; database management; and interactive and real-time data analysis.

Data collection spans a satellite network three times the size of that in 1985, automated reports from buoys, ships, and planes, and hundreds of thousands of remote automated sensors. In addition, NOAA contracts for data reporting with regular commercial sources, such as the offshore oil industry, with several tiers of regular users who exchange their observation services for reduced rates on NOAA weather services. Many federal and state government agencies provide reports to NOAA at least daily. Data exchange with the European Center for Mid-Range Forecasting and other foreign weather and environmental agencies has increased.

Within NWS the biggest changes have been in field and small-scale modeling and mesoscale forecasting. Central modeling at NMC has steadily improved. The Class VI computer at Gaithersburg has been operating for four years.[12] Twenty-eight day weather forecasting is routinely available on 84% of the contiguous 48 states, with accuracy approaching that of six-day forecasts in 1985. With improved global data collection and modeling, NWS forecasts climate two months ahead; in 1985 three weeks was the horizon of the rudimentary computer models.[13]

Weather offices receive satellite updates every two minutes. Doppler radar and remote ground stations profile information on wind, precipitation, temperature, etc., vertically through the atmosphere every five minutes. The doppler NEXRAD (Next-Generation Radar) system will reach 50% completion this year.[14] Weather experts say that 80% of the deaths from tornadoes last year could have been avoided with the earlier warnings that NEXRAD can provide.

Nowcasting has become a reality at local, regional, and national scales, for the continental U.S. and adjacent oceans. The PROFS (Prototype Regional Observing and Forecasting Service) R&D program of the mid-1980s was the forerunner of nowcasting, made possible by the new real-time instrumentation and information technologies -- satellites, automated observations, profilers, computers, and digitial communications.

The NOAA fleet services over 15,000 automated marine data collection platforms, using strategic deployment patterns set by knowledge-based computer models. The deployed sensors are tracked by the Global Positioning System and their positions relayed to the deploying ships and other users in real time.

A related group of sensors, the first to be completely upgraded was the old analog-to-digital tide and water level gauges. They were gradually phased out in the late 1980s with microprocessor based systems. The new sensors offer real-time transmission to NOAA data centers; direct computer interface, avoiding human upkeep; and multivariable sensors for air and water temperature, salinity, currents, wind direction and speed, barometric pressure, etc. The sensors are equipped for telemetry to real-time users such as ships, port authorities and shipping companies; and are directly linked to data collection and data processing computers. These data centers in turn are linked to near real-time users, such as universities. Over 5000 automated tide observation stations are operating.[15]

The new Advanced Weather Interactive Processing System (AWIPS)[16] has enabled a new focus on micrometeorology through the wide use of microcomputers to analyze small-scale weather phenomena. State and local level use of this network by both government and business has increased rapidly. This upgrade of the AFOS system now links 95% of weather offices and directly ties into most digital radar stations, satellite ground centers, and surface observation stations.

Throughout NOAA, ADP must support large mathematical systems, e.g., to perform numerical integration of differential equations for orbit determination or geodetic surveying. NOAA is a leader in developing software for interactive real-time graphic display and large mathematical operations.

NESDIS has become a leader in atmospheric cloud tracking. This enhanced capability may be the only good result of the failure of forecast and tracking information during the tragic 1987 New Orleans incident, which misdirected evacuation and mitigation procedures in the path of the released cloud of arsenic trioxide. The NESDIS atmospheric tracking directorate provides baseline data and modeling time to a wide group of users, dominated by chemical and waste management industries but including environmental associations and state and local governments. Discounts on these services are offered to users which contract with NOAA to enter coded data into a real-time or a NESDIS database. This data must meet strict NESDIS criteria.

Areas of particularly increased data collection include the poles, EEZ, and the southern hemisphere oceans. The main reason for this has been the need for global information to further improve the quality of national weather and environment modeling. Southern hemisphere nations have demanded greater international attention to their climate and environment, and in addition have increased their own activities in data collection, especially from space, and in managing data collection and analysis within their national boundaries.

Information Dissemination

The biggest changes in information dissemination have been the wide use of interactive data and color graphic displays, and the availability of low-cost real-time information to private users and the general public. NOAA serves increasingly diverse users, less focused on key fisheries and marine industries and academic managers and scientists, to planners, citizen groups, elected officials, city managers, attorneys, large and small businesses, and the general public. All want the faster, up-to-date, and comprehensive weather and environmental information offered through NOAA.

Weather information still is by far the biggest product of NOAA, although 'weather' coverage has expanded to incorporate more variables, such as in biometeorology and suncasts (solar radiation flux forecasting). NOAA is still the authority for weather information and forecasts, but many private companies and consortia have taken over the delivery of specialized weather services.

- In 1990 NOAA provided nearly 15 million meteorological forecasts to private and government users; over seven times the number of meteorological forecasts provided in 1980.[17] Another 6-8 million weather forecasts were delivered by private sector and nonprofit services.

The speed and accuracy with which forecasts and severe weather warnings can reach the public has been based in great part on the AWIPS network, which allows any weather office to draw on real-time or near real-time data from 80% of NOAA's surface, air, and space observation stations. NOAA Weather Radio and NOAA Weather Wire Service still provide the crucial link to the general public.

The automated telecommunications system also carries new vulnerabilities. Because of the critical importance of time in issuing flash flood warnings, in 1988 a program was set up to test a flood monitoring and warning system that would automatically issue a public warning under a computerized decision support system, without human intervention. The deaths and damages from the 1988 Liberty Canyon flash flood — without a warning from this system — were attributed to the simultaneous failure of local NWS ground and satellite links. NOAA was cleared of liability in the resultant suits but has since then increased the role for human judgment while ensuring that the best and most recent information is available.

The family of NOAA databases is a system of database hierarchies, rather than a centralized database, with standards for compatibility in data format, communication protocols, etc. In-house workstations, sharing networked peripherals, process data and provide real-time interactive analysis. These relay information to the user in a graphic display, and archive the results of a user's data manipulations. Basic database applications such as search, entry, and retrieval are built into the system. The Man-computer Interactive Data Access System (McIDAS)[18] set in place in 1986 for satellite data analysis, has been adapted to other interactive uses in NOAAnet.

Weather and environmental databases have easy-to-use query languages. Widespread interactive access is made possible by low cost high speed telecommunications and user-friendly information services. Users can reach the interactive database from a stand-alone CRT, graphics display units, or any minicomputer. The system can handle 150 simultaneous users[19] running a mix of large numerical operations, interactive displays, and general database requests. NOAA databases average a total of 23,000 queries a day.

NOAA databases may be accessed individually or integrated searches may be run. NEDRES has grown to be the broadest environmental information database in the U.S.

Assistance is offered to external users with systems and technical problems. Database user software is tiered according to technical sophistication of user; at the low end it is extensively menu-driven.

NOAA supports state data processing centers through education, technology transfer, and training in data management. The winner of the 1990 Westinghouse Science Talent Search used a NOAA secondary education demonstration database to develop a weather model for her county.

NOAA technology transfer supports private sector weather forecasting and economic impact analysis. State and local governments assessing the environmental impacts of proposed estuarine or offshore development have used NOAA data gathering and modeling spinoffs.

Maritime chart use is now over 80% electronic and real time. Under the auspices of the World Meteorological Organization, NOAA has coordinated private sector development of a real time New Hazard warning system. Ships entering flagged New Hazard areas are tracked by Navstar and their computerized navigation system is alerted. Chart printing on demand is available to any computer user throughout the world. The prototype of nautical chart automation was put in place in 1979, and by 1989 chart compilation was entirely automatic. In 1985 the bulk of chart data came from NOAA fleet and marine centers; this has expanded to include photogrammetric data from satellites. Chart costs have increased significantly, although the detail, quality, timeliness, accuracy, and availability have been greatly enhanced through expansion of databases and interactive distribution.

- o Hardcopy aeronautical and nautical chart demand has decreased greatly with the advent of real-time interactive navigation and weather systems on board aircraft and ships. These "flight director" systems are descended from the autopilot. Hardcopy aeronautical charts average $12.00 compared to $2.00 in 1985, and nautical charts now cost $17.00 instead of $5.00.[20]

- o The number of basic nautical charts available has risen from 1000 to over 5000. Where about 2500 chart extensions were available in 1985, the number is now nearly limitless because of interactive graphic display and downloading capability. NOAA delivers -- nearly all electronically -- over 4 million nautical maps and charts per year.[21] An additional 1.6 million charts are prepared and sold by private companies and trade associations. Over 120 companies purchase NOAA data to prepare special applications charts.

- Copyright and liability have become more difficult issues as the private sector becomes more involved in chartmaking. In an important shipping accident case last year, a petroleum shipping company won a suit against a harbor on the grounds that the harbor did not enter significant channel changes into the electronic net as soon as would have been reasonable for the safety of shipping. The issue of whether and to what extent NOAA should retain copyright on charts is as yet unresolved.

Coordination

NOAA has expanded its service to other federal and foreign government agencies as the source of benchmark reference data and up-to-the-minute comprehensive environmental information. NOAA data and services have been in increasing demand by not only the science and environmental agencies but also industry, trade, economic, social service, energy and land use agencies. Several agencies have established computer processing centers directly linked to NOAA databases.

NOAA complements its primary data collection by screening and assimilating relevant data from federal and state agencies.

NOAA's science base and information network increasingly have been called upon by EPA, most recently in setting up a wetlands assessment and monitoring program.

In 1988 an automated data link was established with FAA for computer updating of aeronautical charts and database access in response to increasing FAA requirements due to increased air traffic. Congress increased FAA information system budget appropriations by 18% over requests following the 1987 "twin crashes" of commercial jet planes in Chicago, both attributed to wind shear. A local amateur pilot testified before Congress -- and a television audience estimated at 40 million -- that his warnings hours before the crashes had been ignored by the FAA. The pilot had used commercial software and a real-time NOAA datalink in his forecasts. FAA, NOAA, and the Small Airplane Pilot Association have jointly been developing a real-time weather and chart display system for small commuter airlines.

Congressional oversight of NOAA planning and finances has tightened with the easy availability of current NOAA spreadsheet and resource allocation information. Some LOs have complained that the detailed level of Congressional inquiry and suggestion has interfered with their ability to properly design a nationally consistent data collection program.

Research

Research at NOAA has two main thrusts: improving data collection and analysis, and basic research to understand more about environmental and meteorological processes. R&D has expanded above and beyond its relative increase within the NOAA budget through research programs set up jointly with universities and industry.

International research has expanded steadily. The World Climate Research Program (WCRP) has become a major impetus for integrated NOAA research and data gathering.[22] By allowing real-time communication and coordination among researchers around the globe, information technologies already are making the WCRP a landmark success. The voice/data telecommunications network, originally set up to support field-laboratory-computing center communications, is finding at least as much use in informal discussion among the over 6500 associated international researchers. This system is the first large-scale use of real-time language translation protocols. The network also effectively protects access paths between analysis and raw data, vital since much of the data is closely linked to sensitive national economic information.

The most important and innovative part of WCRP has been the Tropical Ocean/Global Atmosphere (TOGA) program. Like its parent WCRP, TOGA is multidisciplinary, multinational, and addresses the global environment as a complex system. TOGA has required NOAA's research management capabilities (NOAA coordinated private sector research in support of WCRP and TOGA), multi-LO participation, real-time data gathering and dissemination, and new prediction methods. Recent results from the TOGA program and from numerical modeling experiments show that a useful seasonal forecast is possible and that major climatic anomalies can be anticipated six to eight months in advance. Economically important knowledge and services have resulted. Nearly 40% of the 1992 NOAA research budget is tagged for WCRP work.

Much of NOAA's research is geared towards improving the measurement of the atmosphere, ocean, and surface of the earth:

- TOPEX (the Ocean Topography Experiment) is measuring and monitoring global ocean circulation with satellite altimetry.[23]
- The Geodetic Survey achieved its goal of a Comprehensive National Reference System in 1990, with the help of the Global Positioning System.[24]
- The Experimental Cartographic Facility was established in 1988.[25]

As important is basic research on the physical and biological mechanisms driving global ecological and geophysical systems.

Jointly with the National Institutes of Health and the Centers for Disease Control, NOAA has set up a research program in biometeorology. The agenda is split between research on basic environment-dependent physiology and biochemistry and on information structures for the analysis and cross-correlation of historical and current data.[26]

NOAA has pioneered applications of information technologies to large systems analysis and numerical operations. Model-building conventions developed by NOAA have been adapted for applications ranging from urban planning to astrophysics. Hardware and software interactive graphic display of data have also been significant research topics.

Regulation/Resource Management

NOAA has moved away from regulation and towards supporting federal and state regulation through information gathering and environmental assessment. This trend has been driven by Congressional desire to separate institutions collecting and analyzing information from regulatory agencies. A significant exception is weather modification, where a regulatory role for NOAA seems imminent. NOAA is still active in coastal zone management even though many regulatory responsibilities have passed to the relevant states:

- NOAA data and models are used to assess the impacts of proposed state and local regulation (e.g. of deep seabed mining regulation)
- Multispecies fishery and marine resource models developed by NOAA provide the basis for state regulation and have been adopted by many foreign nations as the data structure for their EEZ management
- NOAA monitors an automatic reporting system for sanctuary resource management, tracking permits, activities, and violations.

A complementary, growing role for NOAA is certification. In 1990 the NOAA-led Industry-Government Meteorological Certification Board (MCB) reviewed 65 new and 40 renewal submissions from private for-profit weather information services (all of which rely at least in part on NOAA primary data). Sixty-three percent of the submissions were certified. A growing number of corporations and trade associations have asked the MCB to audit their in-house weather services. Although no regulatory function was planned for the MCB when it was set up by Congress in 1989, the public interest in reliability of weather services has given the MCB certification substantial weight.

Increased fisheries and energy development in the EEZ has been supported and guided by NOAA science and regulation. The volume of commercial catch under license to NOAA has continued its steady 5% per year increase. Two states, California and Oregon, have started controversial trial programs in on-board catch monitoring, with limited success. Preliminary reports to NMFS show that of the 120 ships and boats outfitted, 18 transmitted catches along the projected catch distribution, 26 transmitted catches to within a unanticipated accuracy of 0.5% of allocation, and 67 reported electronic malfunctions. (No data is available on the other nine ships.) Negotiations are continuing with the tuna industry over fair international competition and quota verification.[27]

Innovative application of information technologies to conferencing, secure negotiation, and data consensus management, have helped keep alive the on-again, off-again international negotiations on use and regulation of EEZs.

NOAA is working with Japan's Department of Natural Resources to study their success in real-time harvest monitoring, modeling, and adjustment in multi-species management. Japan's extensive fishing, mariculture, and marine ranching industries have developed an innovative satellite-supported network. It tracks changes in commercial fish and crustacean populations, monitors catch and harvest levels, and adjusts domestic and foreign national quotas according to updated models to maintain sustained yields. As part of a U.S.-Japan reciprocal technology transfer agreement, NOAA-developed robotized buoys and remote environment sensors have been tested in this progam to assess their usefulness for a similar program under NMFS.

Although coastal zone and offshore development has been rapid, NOAA has moved to a supporting role in coordinating state analysis and resource management. This trend has been made possible by real-time monitoring of selected sites and the networking of state databases:

- NOAA was called upon to mediate after Maine was unable to resolve a dispute between marine ranching and offshore energy operations in the EEZ. A U.S.-based multinational, Marine Bio Resources, Inc., laid claims against offshore energy interests that lowered fish yields were due to leakage from undersea wells and pipeline.
- In late 1989 NOAA used a leased video conferencing system to help resolve an impasse within the Coastal States Association on monitoring of migratory shrimp. The electronic conferencing system made a speedy resolution possible by allowing NOAA arbitrators to use consensus-building techniques with a group of representatives from all the involved states.

The rise of environmental malpractice suits, especially involving multinational corporations, has challenged the validity of NOAA's information base for regulation.

Weather modification has re-emerged from research into controversial practice. In 1990 Congress directed NOAA to create an Office of Weather Initiation and Modification Programs in NWS in the wake of several state and private sector weather modification projects following the Midwest drought of 1987-88. The bill was sponsored by

Senator Wood from Nebraska, who in 1988 led a coalition of Midwest states in a suit against Colorado following that state's attempts to increase Colorado River flow by augmenting snowfall.

Audit and Monitoring

Closer NOAA administration scrutiny of budget and accounting data is the result of efforts to streamline the budget. Budget development relies extensively on decision support systems. The emphasis on procurement of information systems for the budget office has been to reduce manual data handling and improve fiscal analytical tools. Information technologies have increased productivity but, more importantly, have improved the capability of the budget office to track budget data and performance on a fine scale. Although budget models and data are maintained separately within NOAA administrative offices, an informal "NOAA spreadsheet" is widely used in the LOs to assess how possible changes in the NOAA budget will affect their programs.

As yet unresolved is the broad issue of economic uses of NOAA data. The well-publicized disruption of commodity futures markets last year was attributed by many commentators to the use of NOAA data and NOAA-developed weather and crop impact models. The responsibilities of current and ex-NOAA employees, business interests, and traders in this incident and in general are still undecided.

The increase in NOAA-wide data integration and the near-universal access to minicomputers has increased concern about the reliability of NOAA weather and environmental databases. Database quality assurance has become a major role for NOAA administration. Through the 1980s the amount of observation data available increased faster than the ability to sort and verify information. NOAA last year charged an internal task force with three program tasks: technical quality assurance at the data gathering stage; sorting at the database update and correlation stage; and a retroactive system to assess the quality of past data with the improved quasi-intelligent sorting programs now available.

Legal issues still plague public and private forecasting services.

Some precedents have been settled, however, limiting the responsibility of NOAA in interpretations of its raw data, for example in forecasting water supply for utility and municipal reservoirs; air freight and shipping routing; and solar and wind energy planning.

Personnel

The NOAA workforce has been reduced to 8800 from a high of over 14,000 in 1984.[28] This streamlining, in great part directly linked to automation, occurred in two approximately equal steps over the past five years. In the late 1980s, intensive office automation, expanded regional administrative support centers, and privatization of more routine weather data processing thinned the lower levels of administration and management workforce. This initial reduction was partly countered by the 1989 creation of an independent NOAA. Second, a growing trend to reduce lower-level technical personnel accelerated between 1987 and 1990 as thousands of remote environment monitors, weather observation stations, buoys, and satellites replaced ground observers and other technical field personnel.

Over 40% of NOAA workers are in the science service or in technical or senior positions in the civil service, compared to less than 25% in 1985.[29] Competition for meteorologists and environmental information specialists remains high, unlike the heydays of the 1970s and 1980s when NOAA was almost the only place to do interesting meteorology. Although NOAA has the attraction of state-of-the-art supercomputing, private sector opportunities for meteorologists have greatly increased as the economic value of weather and environmental climate information is more widely recognized. The average tenure of GS-12 and above meteorologists at NOAA has dropped by 25% over the past ten years. The universal availability of weather information and economic impact analysis have made meteorologists so valuable in the private sector that NOAA cannot compete with private pay scales. The fastest-growing occupational areas in NOAA are information sciences, especially in database management, and large physical and biological systems specialists.

Continuing education has burgeoned due to the availability of combined on-line and classroom academic programs. Some programs are organized by research centers around the world and enroll students from many nations; others are part of NOAA or federal training courses. Response has been greatest in information sciences, computer and data management training, and in the scientific seminar and graduate programs. The proportion of NOAA employees with advanced degrees is higher than ever. At any given time 18% of NOAA staff are taking a course, 74% have taken a course in that year, and 39% have studied through the family education program.[30] Plans are on the board for a NOAA University to take advantage of video courses and seminars offered by universities around the world.

NOAA now has one workstation for every 1.2 workers, exceeding the planning target of one workstation for every two workers.[31] This was driven by the rapidly decreasing costs of stations and the need for specialized, dedicated workstations for many NOAA applications.

Procurement/Support Services

NOAA administrative support services have centralized information coordination services. Protecting supporting utilities, such as electric power, cabling, and air conditioning, is increasingly important. A magnetic tape inventory system ensures that all backups are up to date. Because of the importance of data compatability across databases, the central office organizes NOAA-wide data dictionaries.

The central information systems coordination office channels access to commercial databases, literature surveys, and bibliographic services. The central office also takes care of database management system capabilities for management and administrative information for cross-LO and cross-agency project and budget coordination.

The demand among NOAA professional scientists for enhanced electronic and hardcopy graphics has been answered by development of specialized software. In addition to real-time access to the results of the daily central weather forecast model, rudimentary weather models equivalent to the centralized forecasting models of the early 1980s are available on minicomputers.

Since NOAA became independent in 1989, the line offices have handled their own procurement of computing and peripheral information technologies. The diversity of small special purpose computers in both government and the private sector has been encouraged by the availability of networking and cross-CPU software. The ability to tailor computing capacity to the specific needs of the user has increased the efficiency of the individual NOAA employee.

With the proliferation of computer files on employees, sensitive administrative information, health and safety information, and industry-related data, the need for secure management of NOAA data has grown. Two trial programs are now in operation. One relies upon a freestanding computer to maintain sensitive files; the other uses a combination of restricted access and file encryption.

Information technology has the primary force behind the decentralization of substantive management responsibility at NOAA. The line offices shoulder most specialized procurement, contracting, and personnel functions, although NOAA administration maintains effective oversight responsibility, keeping close to line office practices through information networks and electronic reporting systems. Centralized federal budgeting, payment, and supplies has eased the administrative burden on individual agencies and allowed NOAA's small administrative staff to focus on keeping up with the state-of-the art in special agency needs. The most recent electronic survey of NOAA employees showed that 60% were "satisfied" and 20% were "very satisfied" with the improved procurement services.

The nationwide NOAA administrative network, initially operated on increasingly expensive leased public lines, moved to a dedicated NOAA telecommunications system with a private satellite link in 1987. The move was made because of the rising costs of leased common carriers. A second transponder with double the capacity will be launched next year. Budget and personnel data are transmitted under appropriate federal encryption standards.

Planning

Standardization of networking software and cross-machine mail and the nearly universal access of professionals to microcomputers and internal electronic mail has increased awareness of the links among the line organizations. All employees are encouraged to contribute to early planning and offer suggestions to coordinate programs and facilities across LOs. Local area networks within each NOAA building are extensively used for scheduling, administrative communications, and exchange of data, graphics, and analysis.

Planning is more continuous and more detailed because of the ability to track and coordinate data acquisition and processing needs throughout NOAA. The wide spread of the information gathering net has enhanced planning by increasing input from dispersed offices, who can initiate and comment on NOAA plans. Longer term central planning concentrates on designing and analyzing alternative NOAA-wide systems for collection of environmental data and delivery of information products.

Verifying the source and status of plans has become difficult. Although formal, secure protocols have been established to prevent misuse, last year three distinct versions of the NOAA FY92 budget were submitted simultaneously to Congressional committees. The problem arose within cross-CPU formatting protocols built into the electronic datalink to Congress.

INFORMATION TECHNOLOGIES IN NOAA: 1995

Mission

Through the linkages of information technologies NOAA by 1995 may move substantially closer to realizing its integrated mission. NOAA should be a 100% networked agency by 1995. NOAA's streamlined mission hinges on federal responsibilities: providing reliable, comprehensive information; setting standards; and interstate and international coordination.

Even with the privatization of satellite support operations, NOAA will expand its work in space with the new generation of sensors on multiuse platforms and the space station. Ocean activities, especially within the EEZ, will increase in tandem with development of the seabed, marine energy, fisheries, and with concern about marine pollution.

Throughout NOAA there will be more emphasis on research, especially on large-scale systems. NOAA should become even more of a global data repository and gateway. A decade of change is summarized in Exhibit 7.

Information Collection and Analysis

The application of artificial intelligence, robotics, and continuous satellite positioning will revolutionize data collection.

NWS information technology plans for the mid 1990s include a significant supercomputer upgrade, most likely the gallium arsenide-based Cray X-2 multiprocessor.[32] The Cray X-2 should have over three times the processing speed of the supercomputers of a decade ago; 2.6 gflops (gigaflops, million floating point operations per second) compared to 0.7 in 1985.[33] NOAA modeling and data feed-in capacity should be enormously enhanced above and beyond these processing speed advances. The reliability problems of the first generation gallium arsenide multiprocessor have been addressed in the X-2.

A wild card for 1995 is general systems modeling on minicomputers. Some projections believe that minicomputer systems will approach the capabilities of the late 1970s Cray supercomputer, although the most sophisticated models might an hour to run.

Remote data collection will expand to include robotized buoys and gauges, located and controllable in real-time by satellite. Intelligent "mother buoys" will coordinate deployment and select environmental variables to be measured. The first generation of remote environment sensors were put in place during the late 1970s and 1980s. Beginning in 1991 second generation remotely deployed intelligent microenvironment sensors (RDIMS) linked by satellite will be deployed. Eight thousand prototype aquatic RDIMS have been placed in the U.S. Great Lakes. These remotes have an average useful lifetime of seven months, 12% greater than anticipated.[34]

Complementing the dispersed microenvironment sensors will be an expanding satellite network. GOES-Next and NOAA-Next will be operating through the 1990s. Real-time transmission will reach not only NOAA and other international centers but nexus remote sensors. Data transfer rates between orbit and ground tripled between 1985 and 1990, and are expected to increase one and a half times by 1995.

A major new initiative is the National Coastal Environment Survey (NCOES), which will run through 1994.[35] NCOES coalesced following a 1989 NOAA survey which showed that coastal development, marine farming and ranching, and at-sea waste incineration were rapidly altering the ecosystem of tidal areas. State data collection will operate in tandem with NOAA feedback analysis, model enhancement, and environmental assessment.

The first joint Navy-NOAA satellite platform, Ocean 1, will be launched in to-be-assembled modules during 1995 and 1996.[36] The crucial innovation making this joint venture acceptable to Congress was the satellite oceanographic data security selector developed at the Center for Advanced Computing Sciences, sponsored by NOAA, the Navy, and NASA, the "3N" of the 1990s. This system is noteworthy not only for its engineering and scientific successes but for its survival through data security and segregation issues that reached the floors of the U.S. Congress and the United Nations General Assembly. The security system will be a next-generation version of that on Navy polar satellites, which in nearly six years of successful operation have shown that the information needs of the international scientific community and the security concerns of the U.S. Navy can be securely segregated in all phases of data gathering, processing, and transmission.

- The plans for a NOAA/EPA observation package on the space station are in the final stage of negotiation. It is anticipated that the package will be put in place during the second year of space station operation, in 1998.[37]
- The international polar platform, to be operated for the U.S. by NOAA, will improve polar orbit observation and increase data on the tropic belt, a priority interest of the International Polar-Orbiting Meteorological Satellite Group (IPOMS).[38]

Upgraded mainframe data handling computers will receive updates from around the world; the average hour including 4000 ship and aircraft reports, 2900 radar readings, 550 satellite images, and 45,000 land, river, and ocean RDIMS reports.

NWS remote weather observation will continue to improve efficiency and quality. Manned weather observation stations will average two per state, continuing their steady decrease since 1990. The local protests that characterized the proposed closing of such stations in the late 1980s have been allayed by the proven enhanced capabilities offered by automated observation stations in trial state programs.

In 1993 NWS will begin a trial program to receive private sector and individual observations in a highly controlled and standard format. Liability concerns have delayed the introduction of this program on a nationwide scale.

The decommissioning of NOAA ships, which occurred at a brisk pace in the past five years with the deployment of the new satellite and marine sensor network, should level off. Primary data collection by NOAA ships and aircraft, while still their most important function, has been extensively supplanted by remote sensors and satellites.

Information Dissemination

Over the next five years NOAA data and information products will be of better quality and reach more people. Users will be able to individually tailor weather reports and charts with a few natural language instructions.

AWIPS now links all NWS offices and by 1995 will allow direct individual communication with over 70% of remote environment sensors. All sensors equipped with two-way satellite channels or linked to an intelligent mother control will be directly addressable by any NWS worker with the proper access code. The modular design of AWIPS will make the upgrade easier and cheaper than the change from the primitive AFOS network. Portable terminals will give field personnel a two-way near real-time data link into AWIPS.

The first commercial building linked directly to NWS weather updates will be the new state government offices in Topeka, Kansas, to be completed in 1993. The building's alarm, telecommunications, and environmental control systems will be wired into NWS forecasting and alert updates. The updates are a specially designated subset of the NWS Weather Radio broadcasts. The trial is under the joint supervision of NOAA and FEMA. Interactive real-time severe storm warning and response programs also will be coordinated with FEMA.

Satellite transmissions will be 50% encrypted by 1995. The push from the Departments of Defense and State for increased protection is based on increasing economic and security value of the resource and positioning information relayed by NOAA satellite. Marine fishery and ranching industries have also urged greater confidentiality.

NOAA plans to offer new chart series for coastal biozones, sea floor, EEZ, and atmospheric particle movement.

Charges for data downloading could increase 15% (in constant dollars) by 1995. Congress is expected to resolve its discussion of Vital National Data Access by 1992, setting access and charge policies for commercial and public users for weather and environment data.

Over the next two years NOAA plans to expand its on-line and free dial-up help program for users of integrated databases.

Coordination

Agencies are increasing joint information planning to minimize overlap in data collection and ensure data compatibility across agencies. The "3N" -- NOAA, NASA, and the Navy -- coordinate real-time space operations as well as long-range system planning.

International competition for orbit space could become troublesome by 1995. The decreasing cost of space observation and wide use of encrypted telemetry will challenge NOAA's successful history in international space cooperation.

With the increasing importance of weather data in national security, NOAA's interaction with the military is increasing — to the point of discomfort for some NOAA employees.

Federal coordination of information exchange will be formalized under the 1990 OMB directive DT-90/341 on cross-agency program tracking and coordination.[39] This tracking program will target the maze of informal interagency contacts and data exchanges, for instance among all groups working on aspects of offshore energy development. Advocates say that it will reduce under-the-table exchange of sensitive data and streamline related programs across government by funneling communications into OMB-monitored fiberoptic lines. Critics argue that this technological fix of the flow of invisible information will stifle innovation and reduce public access to federal information.

NOAA will have coordinating responsibility in national water resource management. Although slowed from earlier projections, national water demand is projected to increase 50% from 1990-95 to a critical level.[40] NOAA's improved long-term river forecasts and extensive monitoring network will be the foundation of integrated water resource management, both by states and in federal programs coordinated with the U.S. Army Corps of Engineers and the Department of the Interior. NOAA projects a further 10% yield from water management projects due to river forecasting.

Research

The IGBP will continue to be the centerpiece of NOAA basic research. As it moves into its second ten-year phase the large systems expertise of NOAA will become increasingly important in guiding further research.

Increased grants and joint research will shift a larger portion of NOAA research to universities. Joint publications by NOAA scientists with university researchers should increase.

Research will focus on improving NOAA's information services and baseline measurements of the biological and geophysical world; for example, three-dimensional mapping of the Earth's electromagnetic field.[41] NOAA mathematicians are continually improving methods for sorting and modeling data.

Regulation/Resource Management

As the clearinghouse for information on the EEZ - oceanography, resources, and commerce — NOAA has been placed in the center of integrated EEZ management. Although NOAA holds no regulatory authority, debate continues over the validity of data used by states and industry associations in using the EEZ. As the source and standard-setter for most of that background information, NOAA has spent increasing effort on verification and arbitration of data use by third parties.

The NOAA Weather Initiation and Modification Program will issue guidelines in 1993 for storm mitigation and precipitation enhancement. The Program office also represents the U.S. in international forums on weather modification research and oversight.

If current trends continue, international NOAA activities in regulation and resource management will exceed domestic programs by the mid 1990s.

Audit/Monitoring

Data certification and monitoring will be the fastest growing activity for NOAA in the early 1990s. Over 150 new commercial weather/environment data services using NOAA databases are established each year — and many times that number of informal, limited operations.

Validation and data trails are the most important responsibility of the auditing office. New data trails are being developed to solve past problems in keeping records of non-automatic database updates. This is especially important with the increase in use of NOAA records for litigation; by 1995, 25-27% of certified data search requests will be prepared for litigation, compared to about 18% in 1985.[42]

Administrative auditing will be improved though automatic tracking that flags significant deviations from budget, schedule, etc.

Personnel

The NOAA full-time workforce should stabilize at around 7500.[43] Further office automation and the application of robotics and artificial intelligence to observation will be responsible for the personnel decreases over the next five years. Administrative personnel will be far fewer, with the workforce bifurcated into research and data management. The average employee will spend more time in years with NOAA, but will move in and out of the agency more often.

The NOAA University by 1995 should by offering up to at least 800 courses, ranging from off-site year-long academic sabbaticals to half-day management training on interactive video. The Health and Safety Office wants to biomonitor all NOAA field researchers by 1995 in a joint program with the biometeorology research lab. Although the program would offer health and danger protection benefits, reaction from the candidates so far has been mixed.

The centralized federal personnel offices could produce micromanagement problems if it follows through on its computer-based time and effort accounting plans.

Procurement/Support Services

Nearly all responsibility for procurement and support will be further centralized in the federal government. Responsiveness should improve significantly with the selective use of decision support systems.

The complete networking of NOAA will ease management communications. Increased vigilance will need to be paid to selective protection against foreign intrusion into NOAA telecommunications. Because of past abuses, over the next few years proprietary and nationally sensitive resource data will be isolated into a stand-alone mainframe with physically limited access.

The application of modular design and robotics in manufacturing will reduce the cost of much sensing equipment.

Planning

Integrated planning is approaching real time. Primary planning responsibility is centralized in NOAA administration, supported by the access to detailed information. Knowledge-based programs are used for long-range design of information collection systems. These programs optimize future observation capabilities, e.g. satellite and flexible remote sensors; as well as agendas for regional, national, and international data collection. At the LO operations level, optimizing programs are used to deploy sensors in real time, and adapt their data collection to changing environmental conditions, user needs, and system load.

SECURITY, PRIVACY, AND PUBLIC INFORMATION IMPLICATIONS

Security and Data Integrity

Database integrity is crucial to NOAA. The source and authenticity of data must be assured at all stages: collection, database entry and update, and correlation, display, and dissemination. Updates of databases are conducted for the most part by knowledge-based systems, cutting the human operator out of the system as much as possible to minimize opportunities for careless or deliberate data falsification. Human operators maintain specialized and public-use databases. However, the harvesting, sorting, checking, correlating, updating, and model use of real-time data from satellite observations, buoys, radar, remote monitors, etc., is all done automatically by computer, which logically sorts the information.

With the nearly complete networking of data collection and NOAA operations, system security is another concern. The star design of AFOS contributed to the near-failure of weather services in two states in 1988. Since then the AWIPS design has been modified to limit the number of weather offices relying on a central nexus and to contract for priority access to a backup communications net. Backups have become increasingly important for both data collection (satellites, remote monitors, etc.) and databases. NOAA has taken a dual approach, combining hardware support with contingency arrangements to redeploy reliable equipment. Error-correcting codes are used on transmission of all weather information on AWIPS. NWS is investigating techniques to protect communications lines from interference — jamming, interception, or failure. Informal international agreements provide for backup protection, although this is mostly limited to systems such as GOES where data collection is already an international division of labor.

Protection of nationally sensitive data is of growing importance. The comprehensive information available in NOAA's databases bears directly on U.S. and foreign trade, economic strength and projections, and resources production — primarily mining, energy, transportation, agriculture, and fisheries industries. National information has value in weather and climate forecasting, environmental condition assessment, and more questionable applications to international trade and commodities markets. The problem has been exacerbated because NOAA information systems from the 1980s were designed to maximize public accessibility to data and services. The WMO has been a growing customer for NOAA on behalf of developing nations, to reduce their competitive disadvantages in their access to and capability to analyze environment and weather data. The international market in environmental information has moved to a formalized barter economy, trading data packages for rights to gather data. In 1992 a Congressionally authorized interagency commission will begin investigating transnational flow of environmental information. Its preliminary agenda includes the use of proscribed categories, encryption, and regulation of corporate data transfer.

The issue of separation of military and NOAA data is growing with increasing coordination between NOAA and the Department of Defense, especially the Navy.

Privacy

Confidentiality of commercial information is of particular concern for NOAA. The mission is to provide easy and ready access to shared data for a wide variety of users. The Fishery Information Network (FIN) has provided the model for data security architecture for NOAA commercial databases. Breaches of security in the late 1980s, driven by the competition for resources in the EEZ, spurred improved methods of multi-level security.

Several corporations and communities have lobbied for more private, on-site control of NOAA data collection equipment, arguing that their rights to privacy are being violated. Satellite and monitoring technology has allowed NOAA to track some environmental conditions on a scale of meters. NOAA maintains — and so far has been supported by Congress — that the need to ensure consistent and verifiable data for vital national services is preeminent.

To maintain confidentiality of information obtained from industry, it is placed in "controlled information" databases, maintained separately from the rest of NOAA's databases and not available to the public.

Public Information

The traditional challenge for NOAA has been to make its information as accessible as possible. Its primary mission still is to provide information — in forecasts, storm warnings, charts and maps, and databases. NOAA has put extensive effort into making user interface as simple, interactive, and powerful as possible.

NOAA provided nearly 15 million meteorological forecasts in 1990. The public receives most of its weather information by radio and television. Over 12% of businesses subscribe to NOAA weather data services; among weather-sensitive industries, such as agriculture and construction, subscription ranges from 40-68%.

All charts and maps are available in hard copy or digitally. Although the variety of NOAA-published maps has decreased, user downloading of graphic displays and commercial services can generate an endless variety of individualized maps.

Equity of access is becoming more important with the proliferation of NOAA data services. Commercial and economically sensitive information has increasingly been segregated inside a coarse two-tier system. The first tier, of sensitive data, is maintained internally. It is physically isolated and access is controlled by passwords and optically coded identification cards. The second, separate tier consists of interlocked public databases.

A coalition of public interest environmental groups has led a campaign against "hidden use" of NOAA data in state and federal regulation. A bill currently pending in committee requires regulatory agencies to establish publically available source records for data used in specifying and enforcing regulations.

Exhibit 7

INFORMATION TECHNOLOGY AT NOAA

1985, 1991, 1995

CATEGORY	1985	1991	1995	KEY FORCES
MISSION	To provide integrated information and services related to the oceans and atmosphere. Within the Dept. of Commerce.	Same as 1985 in an independent NOAA. Emphasis on comprehensive data management & verification More international work.	More ocean work: energy, minerals, fisheries, climate. NOAA as data clearinghouse. More public, foreign users.	Resource competition. Real-time networking and telecommunication technologies. Economic sensitivity to weather.
KEY IT FUNCTIONS				
Info Collection and Analysis	A network of ships, data buoys, planes, satellites, and laboratory research; central computerized modeling and forecasting.	More automated, remote real-time data collection Satellite data volume up. AWIPS 80% in place. More from EEZ, poles. More institutional sources.	Over 1 million automated environment sensors. AI and robotized sensors. Coded transmissions. New space platforms. NOAA 100% networked.	Improved automated sensing equipment; demand for local level analysis. Internal NOAA networking and supercomputers.
Information Dissemination	Extensive public weather information and forecasting system; limited databases with limited access. Support of other agencies. Charts and maps.	Interactive graphic displays of real-time data. Electronic charts dominate. More private value-added services. Integration of databases.	Nested databases 100% integrated. Real-time interactive storm warning and response. Direct, encrypted satellite links.	Growth of private environment and weather services. Wired nation. Demand for real-time, easily grasped, tailored information.
Coordination	Established with many federal agencies; some international research and negotiation.	Move to a support role for other agencies. More international coordination of research and data mgt.	Extensive EPA-NOAA coordination. Water resources mgt. Need for space coordination.	Importance of NOAA data to federal activities. Demand to streamline data collection & mgt.
Research	Supports 15 mission-related research labs, including GFDL; 20 fishery labs. International R&D programs.	IGBP a focus. Research to optimize data collection and mgt. Large systems modeling. Integrated EEZ research.	More NOAA research done outside labs. IGBP important. All labs linked to real-time observation network.	Improved data & modeling Desire to maintain int'l leadership. Need for basic research to support mission.
Regulation/ Resource Management	Management of fisheries, coastal zone, ocean energy & minerals. Protection of marine mammals, habitats.	Trial real-time resource and sanctuary monitoring. Certification of private databases and services.	Integrated EEZ mgt. supported by real-time resource monitoring. Weather modification.	Conflicts over resources and need for integrated mgt. to optimize yields. Need to control EEZ.
OTHER FUNCTIONS				
Audit/Monitoring	Standard admin. audits; start of data collection and storage standards.	Focus on compatibility & reliability of data; liability issues.	Reliability of data the primary concern. Watchdog on US & corporate data.	Increasing amount and use of NOAA data. Database mgt. advances.
Personnel	15,000 employees, many scientific. DOC RASCs handle many admin. needs. Geographically dispersed.	Fewer employees due to OA and remote observation, data collection. More technical, info. experts.	Stable workforce split into science & data mgt. More sabbaticals for education, retraining.	Automated observations. Competition for some scientists; need for information managers.
Procurement/ Support	Little networking or LANs. Slow acquistion of stand-alone PCs. Few info. security concerns.	Support of data collection Cross-database dictionaries. Dedicated telelink. Decentralized procurement.	All micros linked to mainframes. Secure databases for fisheries, agriculture, EEZ.	Need for state-of-the-art IT; importance of data system support. Diverse mission.
Planning	Manual coordination of planning offices at each LO, NOAA Admin., and DOC. Not networked.	More continuous, automated. Emphasis on coordinating data systems. More LO-integrated.	Decentralized and real-time. Goal to optimize integrated federal data collection.	Desire to coordinate NOAA and federal data collection and mgt. Efficiency improvments.
Security	Debate on backups, from satellites to data files. Fishery database protection. Passwords only security measures.	Conflicting private interpretations of NOAA basic data. Concern over hidden use of NOAA data in regulation.	Transnational data flow of EEZ, corporate data, economic impact analyses. Separation of military & NOAA data a concern.	
Privacy		Protest over micromanagement by budget and personnel offices.	Privacy of state, industry, citizen operations with ubiquitous NOAA data collection.	
Public Information		Equity of access to databases. Worry over quality of private weather services.	Protection of satellite-ground transmissions.	

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1. E. Paul McClain, Environmental Satellites, reprint from McGraw Hill Encyclopedia of Environmental Science, 1980. M. Mitchell Waldrop, "A Silver Lining for the Weather Satellites?" Science 226, 14 December 1984, 1289-1291. NOAA Magazine, "They've Got You Covered: The Geostationary and Polar Orbiting Satellites of the National Oceanic and Atmospheric Administration," October 1977.

2. Linda Starke, "Automated Forecasting: Better Weather Ahead," Government Computer News, August 1984, pp. 22-23.

3. AFOS and its status are real. Linda Starke, "Automated Forecasting: Better Weather Ahead," Government Computer News, August 1984, pp. 22-23; and NOAA Information Technology Systems Plan, July 1984.

4. Natural Hazards Observer, "Environmental Data by the Megabyte," November 1984, p. 8.

5. James Gleick, "They're Getting Better About Predicting the Weather," The New York Times Magazine, January 27, 1985, p. 33.

6. IFLOWS is real.

7. This is a real NOAA program.

8. Department of Commerce, NOAA, Environmental Research Laboratories: Programs 1982 and Plans 1983, December 1982.

9. NOAA Information Technology Systems Plan, July 1984. The ratio of 4 workers per terminal is for the Oceanography and Marine Services, NOS in 1982. We extrapolated this to 1985 and used this for all of NOAA.

10. This is a real database.

11. The Fishery Information Network (FIN) is a real integrated data system, started in 1985. It is a joint effort of the regional Fishery Management Councils, interested states, and NOAA/NMFS Fisheries Centers. The design builds on existing state and NOAA fishery data systems.

12. 1985 NWS plans call for the Class VI computer to be installed in the National Meteorological Center in 1986.

13. These are extrapolated from current capabilities. Linda Starke, "Automated Forecasting: Better Weather Ahead," Government Computer News, August 1984, pp. 22-23.

REFERENCES (continued)

14. The costly and controversial NEXRAD system has been a priority interest for NWS for several years. The technology is available but funding has not been allocated to completely update the existing radar system.

15. In 1984 Oceanographic and Marine Services, NOS/NOAA, maintained approximately 15,000 benchmarks at about 3700 historic and operating tide stations. (NOAA Information Technology Systems Plan, July 1984.)

16. AWIPS is real, a planned upgrade for the 1990s from the existing AFOS network. The AFOS network, outlined in the 1985 section of this scenario, links major weather field offices and all NWS National Centers through the Systems Monitoring and Coordination Center. The upgrade to AWIPS has three major goals — to include more offices in the network; to broaden the sources of data and information services available on the network; and to improve the technical operation of the system, in terms of the volume of data transmitted, accessibility, ease and diversity of user interface, speed, data storage and display, and reliability.

17. The baseline 1980 estimate of two million meteorological forecasts per year is taken from Department of Commerce, NOAA, The NOAA Story, January 1980, p. 9.

18. Commerce Business Daily, Issue No. PSA-8760, Wednesday, January 23, 1985, H - VAS Data Utilization Center System. This notification describes NOAA plans to install, by 1986, McIDAS, Man-computer Interactive Data Access System in its real-time processing of satellite data.

19. NOAA Information Technology Systems Plan, July 1984, extrapolated from a plan for 70 simultaneous users in the late 1980s.

20. From the NOAA Information Technology Systems Plan, July 1984, Oceans and Coastal Programs.

21. In 1980 NOAA distributed 2.5 million nautical charts and maps, half of which went to other government agencies. Department of Commerce, NOAA, The NOAA Story, January 1980, p. 11. We assume this number will grow with increasing demand, but that the bulk of the growth will be in the private sector.

22. The IGBP is a 20-year global undertaking scheduled to begin in 1987. International discussions on the agenda, organized by the International Council of Scientific Unions, will be held in 1985-86.

23. TOPEX is real, planned to run into the 1990s.

REFERENCES (continued)

24. *NOAA Information Technology Systems Plan*, July 1984.

25. *NOAA Information Technology Systems Plan*, July 1984. The Experimental Cartographic Facility was proposed in 1984 by NOAA/NOS to focus and expand cartographic R&D. We assume that after several years of discussion and formulation the concept was approved as part of NOAA's research mission.

26. Although no current research program exist in this area, biometeorology is becoming established as science and area of public interest. Several television stations include "healthcasts" as part of their weather services.

27. Setting and enforcing fisheries quotas is a longstanding issue that will not be defused by information technologies. However, information technologies will provide new resource modeling and monitoring capabilities.

28. The basis for this NOAA-wide projection is a current estimate by the NWS that automation could replace 5000 workers over the next ten years.

29. Taken from J.F.Coates, Inc. interviews in 1984 with over 50 NOAA personnel, who estimated a 26% emphasis on science at NOAA now, with hope for increased emphasis in the future.

30. Demographers project that adult education will be the fastest growing area of education. Corporations are offering more retraining and continuing education opportunities. We expect that the government will offer more in-house training and seminars, as well as sabbatical arrangements, especially to attract highly qualified professionals to government service.

31. The goal of two employees per workstation is taken from Ocean and Meteorological Services, NOS, and extrapolated to the rest of NOAA.

32. The Cray X-2 is ficticious. NOAA is likely to acquire at least one substantial supercomputer upgrade by 1995. (The first 19__ Cray-1 was replaced with a CDC Cyber 205 in 1984.) Although limited modeling work may be carried out on smaller computers, NOAA will still need a central top of the line supercomputer for its global climate modeling and forecasting. A few manufacturers could have first-generation gallium arsenide-based computers developed by the mid or late 1990s.

33. Peg Kay and Powell, Eds, *Future Information Processing Technology*, NBS SP 500-103, 1983.

REFERENCES (continued)

34. RDIMS extrapolate existing data collection trends towards smaller scale environmental monitoring and analysis; automation and robotization managed by knowledge-based software; centralized control of large networks; and multidimensional, real-time measurement of environmental variables. Using programmable sensor modules, cheap and flexible data collection units for use in any environment could be built from a small library of basic components.

35. This is ficticious. It is included to illustrate the need for NOAA scientific and data support of complex assessments with political and economic ramifications.

36. Ocean-1 is imaginary. It is based on the existing close coordination between NOAA and the Navy and the longstanding budget pressure to reduce overlapping data collection. The projection relies on information technologies to address the issue of segregating military and civilian data.

37. Current NASA plans call for launching of the space station in 1995; we allow two years' slippage.

38. The IPOMS is real. A polar platform has been discussed, although no formal proposal has been made. It would be a logical and low cost project for international scientific cooperation and to gather important, global data.

39. A hypothetical directive.

40. The projection on water demand is taken from Warren Viessman, Jr. and Christine DeMoncada, State and National Water Use Trends to the Year 2000, a report prepared by the Congressional Research Service for the Committee on Environment and Public Works, U.S. Senate, May 1980. The role of NOAA in future water resource management is hypothetical.

41. Research in mapping electric discharges and changes in the electric field is in progress at the Environmental Research Labs, according to U.S. Department of Commerce, NOAA, Environmental Research Labs, Programs 1982 and Plans 1983, December 1982.

42. The baseline 1985 number is taken from a project-related workshop with senior NOAA managers.

43. This estimate is taken from a project-related workshop with senior NOAA managers.

CHAPTER III

BI-ANNUAL REPORT TO CONGRESS ON INFORMATION TECHNOLOGY AND GOVERNMENT
U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
January 15, 1991

HIGHLIGHTS

The growing capacity and declining costs of information technology have significantly improved the ability of the Bureau of the Census to fulfill its mission. Since 1985, the Bureau of the Census has increased the quantity, range, and quality of its information; expanded its services to federal government agencies, state and local governments, other national governments, and the private sector, while decreasing its operating costs per unit of information collected or disseminated.

These improvements are largely a result of the installation of four Sperry 1101/90 mainframe computers[1*] between 1986 and 1989 which in turn have furthered the move to automated administration and data collection, capture, and analysis. These changes are best represented by the proposed research on continual or rolling censuses and surveys over the next decade. Innovations at the Bureau of Census have faced repeated challenges to the need for a government census and to the established practices of Census in protecting the confidentiality of responses and the quality and relativity of data. Despite these challenges, Congress and the Courts have reaffirmed the need for a government census to ensure the reliability, validity, and confidentiality of the data on which government policies are based. Exhibit 8 presents the findings of the Commission on the Future of the Census on the accomplishments of and challenges to the Bureau.

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[*] References are at the back of the scenario. These references give the source for, the logic behind, or the explanation of the specific illustrations, projections, or assumptions included in this scenario.

Exhibit 8

Findings of the Commission on the Future of the Census

- The Bureau provides higher quality data, at lower costs, and on planned schedule as a result of its information technologies.
- Census has halved the time to delivery, doubled the amount of detail available, and has not substantially increased its costs.
- The Bureau is better able to assure the quality of its data through technologies which improve access to the raw components in the capture and processing of data.
- As automation has increased the amount and quality of data available, the demands for such data have increased dramatically. Census must remain alert to these escalating demands which may require new people and equipment.
- Census may need to reconsider its division of responsibilities with the private sector which could be doing some of the jobs that are now done by Census.
- Confidentiality - the sine qua non of Census data collection - has not been compromised by the Bureau's increased ability to provide Congress, the Executive Branch, and other government and private users with timely, accurate information.
- For reasons of confidentiality, reliability, and completeness there is a continuing government role in the collection of census data.
- The move to some rolling and sample surveys, made possible by the automated geographic files, should improve the timeliness of Census reports with no appreciable drop in reliability or accuracy.
- As a result of the introduction of interactive databases, Census statistics are available much more quickly than ever before to a greater number of citizens than ever before.

Source: U.S. Commission on the Future of the Census, People Count: The Future of the Bureau of the Census, Executive Summary. Washington: GPO, 1990.[2]

The major specific effects of the introduction of information technologies over the past five years include:

- Automation of data entry and capture through Portable Data Recorders (PDRs)[3] -- hand held microcomputers -- and Computer Assisted Telephone Interviewing (CATI)[4] to complement improved mail-out/mail-back processing.
- The establishment of a premier capability for quality assurance in survey design, implementation, and analysis.
- Expansion of the advisory role of Census on data collection, processing, and dissemination to other agencies of government, to the private sector, and to other nations.
- Anticipated delivery of 1990 decennial census reports in 31% of the time to deliver similar reports on the 1980 census[5].
- Increased use of contract professionals for highly specialized tasks and fewer fluctuations in hiring for peak periods.
- Movement to a nearly paperless administrative system.
- Widespread use of microcomputers by Bureau staff coupled into local area networks.
- Improved data handling, storage, and processing through upgraded mainframe computer facilities.
- An automated geographic data base with established methods for updating.
- An increase in public belief in the Bureau of the Census' ability to keep personal information confidential after a period of declining confidence in the mid 1980s.

These changes are largely the result of the changing information technologies coupled with a Congressional and Administration commitment to maintaining the excellence of the Census Bureau. Exhibit 9 summarizes the technological changes over the past five years and the anticipated changes for the next five years.

The next four sections describe the Bureau of the Census in 1985, the developments at Census from 1985 to the present (1991), the anticipated developments by 1995, and the consequences of these developments for security, privacy, and the provision of public information.

INFORMATION TECHNOLOGY IN THE CENSUS BUREAU: 1985

Public Law 100-16, the Citizens Security Act[6], requires each agency to report on the effects of developments in information technology on its functions since 1985. In order to provide perspective on the changes wrought by information technology this section describes the use of information technology at Census in 1985. The discussion uses the functional categories outlined in the Citizens Security Act. After stating the mission of the Bureau of the Census, the discussion turns to those functions for which information technology has the most direct and planned significance: information collection and analysis, information dissemination, and coordination. The discussion then covers other Bureau functions: audit and monitoring, personnel, procurement and support services, and planning.

Mission

The mission of the Bureau of the Census in 1985 as in 1991 was to collect, tabulate, and disseminate information about the Nation's population and economic activities to governments, businesses, organizations, and other individuals. The information provided by Census was and still is central to many policy decisions - either directly as a result of statutory or legislative requirements or indirectly as a key source of guidance and evaluation. For example, the decennial census is mandated by the Constitution for the apportionment of the House of Representatives. Many states use census results for redistricting in their legislatures. By law, Census data is used to determine the distribution of many Federal grants to states and cities and General Revenue Sharing. Many companies use Census data either as a source for or a check on their marketing information. Membership organizations use aggregate census data to target their fund drives.

Information Collection and Analysis

The primary activity of the Bureau of the Census is collecting information. The decennial census of population and quinquennial censuses of economic activity including manufacturing, transportation, construction, agriculture, mineral industries, government, retail trade, and minority and women owned businesses are the largest tasks the Bureau undertakes. The Bureau also does sample surveys on a yearly, quarterly, and monthly basis. The most prominent among these is the monthly Current Population Survey (CPS) which uses a sample of 60,000 households to address questions of employment and unemployment. Every March the CPS includes demographic questions which update, on a national or regional scale, the decennial census data. Using customs declarations and lading documents, Census produces monthly and annual reports on foreign trade. In addition to these continuing tasks, the Census Bureau does special censuses, surveys, and reports on request. Appendix C lists Census Programs and Products offered in the mid 1980s.

In 1985, data was collected with a combination of manual techniques and information technology. For the 1980 census, questionnaires were mailed out to 95% of the Nation's households. Of these, about four-fifths mailed back their filled questionnaires. The Census Bureau had to follow up on the remainder. For the other 5% of households to whom a questionnaire was not mailed, census enumerators visited door-to-door to collect information. For the economic censuses, most responses were forms filled out by individual companies or government bodies. In a few instances, companies sent computer tapes as their responses. The annual, quarterly, and monthly sample surveys were done primarily through telephone interviewing with interviewers manually recording responses.

A central feature of the 1980 census geographic support system was the three-stage file system for identifying the location of responding households[8]. The geographic tools included: maps, address reference files, and a geographic reference file. During the two years before the 1980 census, 900 Census employees and 400 contractor employees prepared maps and assigned block numbers by hand. They created more than 32,000 map sheets that covered the United States. Working with 300 local agencies, Census also created automated files to assign geographic codes to the addresses of questionnaires that were mailed back. These Geographic Base Files/Dual Independent Map Encoding files (GBF/DIME) files covered 1% of the U.S. land area but 60% of the population of the U.S. The job entailed keying over 7,000,000 lines of information into a computer over a period of three years. The third geographic tool -- the Master Reference File -- gives the relationship of an individual block to all higher level geographic units that could be used to tabulate Census data: census tracts, places, states, townships, regions, metropolitan areas, and so forth. Since creation of all three of these tools was manual, involving hundreds of people, errors were inevitable — errors which created inconsistencies between the three files and, thus, in the 1980 data. The chief of the Geography Division at the time said, "In retrospect, the people...who prepared these products should be praised for having done as well as they did — congratulated on the 98 to 99 percent done correctly....The operations used to create the 1980 geographic products...were not designed for the computer age."[9]

Once data were collected, through mail-back of questionnaires or through phone or personal interviews, they were processed at one of three processing centers and then entered into the computers at the Census Bureau's Suitland facility. Much of this processing was labor intensive. Questionnaire check-in, identification of non-respondents, and editing or review of questionnaires was done manually. The questionnaires were microfilmed and read by a FOSDIC (film optical sensing device for input to computer) machine and converted to computer tape. In addition most of the administrative details surrounding the census activities such as paying the enumerators, scheduling, monitoring performance, and progress reporting was also done manually. In the early 1980s it took 180 days from the time data reached an analyst to the production of a report[10]. After the 1980 census, Census attempted to reduce errors and processing time by automating many of these activities for the 1990 census.

While the front end data collection and handling of the census operations remained largely manual through the mid 1980s, the analysis of census and other data became much more technology-intensive[11]. By 1985 the Bureau had three Sperry mainframes (two 1100/84's and an 1100/62), an IBM 4331 assigned to administrative applications, assorted peripheral devices including 79 tape drives, 100,000 reels of tape, 286 on-line disk storage units, 15 remote batch terminals with printers, and 700 remote terminals for displaying and entering data.

In addition to these central facilities, Census analysts began widespread use of microcomputers in the early 1980s largely to avoid the intense competition for access to the mainframes and to enhance their ability to interact with the data. Prior to microcomputers, Census data processing was done largely in a batch mode. By 1985 there were over 475 microcomputers in official use at Census as well as a number of personally owned microcomputers in use at the Bureau[12]. To serve this growing use of micros, Census set up a Microcomputer Information Center in 1984 as a way of sharing information across the Bureau on software, hardware, and other aspects of microcomputer use. Appendix D is the front page from the September 1984 Census Microcomputer Information Center Bulletin.

Information Dissemination

Information is the Census Bureau's primary product. For most of the 1970s and 1980s, collection and processing received more attention than dissemination. However, the decision to release computer tapes from the 1970 census changed the situation dramatically. After the 1970 Census and even more so after the 1980 census, commercial use of the demographic information provided by Census took off. More firms used data as marketing tools and more firms were formed to provide demographic tools, products, and services to business. This growth was reflected in the growing number of seminars put on by Census to educate the public about how to use Census products.

The 1980 census was estimated to create over 300,000 pages of published reports, 100,000 more than 1970. Ten times that much data was to be released through computer tapes[13]. In addition to computer tapes, in 1984 the Bureau began releasing data on diskettes for use with microcomputers. By 1985, IBM compatible diskettes containing the 1983 City and County Data Book (33 diskettes), the 1981 County Business Patterns (22 diskettes), and the 1983 County Population Estimates (1 diskette) were available.

Three other developments of the late 1970s and early 1980s further changed the way Census products were disseminated. First, the amount of micro level data (a sample of responses to individual questionnaires with names and addresses deleted) available to the public increased significantly. In 1970, Census would not identify on the microdata files specific geographic areas having a population of less than 250,000 inhabitants. By 1980 the population cut-off had been changed to permit identification of areas with 100,000 or more people. This change had the effect of increasing the identification of counties on the publicly available microdata files from 104 (out of 3137) of U.S. counties to 350 U.S. counties[14]. This data was of particular interest to businesses targeting advertising and marketing campaigns.

The second development was the State Data Center Program, begun in the late 1970s. In exchange for publicizing census results, assisting users, and providing census tapes to the public for minimal cost, the Census Bureau supplied the officially designated State Data Center with the full set of state census statistics including reports, computer tapes, software, and reference materials at no cost. As of 1984, only Wyoming had failed to take the Bureau up on its offer. These State Data Centers also developed affiliate data centers in their states; by 1984, there were over 1000 affiliate data centers in the U.S. The state and affiliate data centers complemented the work of the census specialists in the Census regional offices who answered the public's questions about Census information and products. In 1983, regional offices received over 100,000 telephone calls -- 44% from businesses; 21% from state, local, and federal governments; 17% from civic groups and individuals; 10% from academic institutions; and 2% from libraries[15].

The third development was the development of CENDATA -- an on line data service of the Census Bureau. Through the commercial computer networks such as Dialog Information Services, users could access the latest information about Census products, press releases, and other services. CENDATA also provided the latest data on commonly referenced topics such as retail sales, housing starts, and manufacturers' shipments.

Coordination

The Bureau of the Census is a service agency to many other federal, state, local, and international governments. Throughout the 1970s and 1980s the demand for Census services grew rapidly. More agencies wanted more data on more topics than ever before. Between 1960 and 1970 there were 1700 requests for special censuses by local governments[16]. Between 1970 and 1980 there were 1600 such requests. Federal agencies also use Census services; for example, Census collects data for the Departments of Housing and Urban Development, Justice, and Health and Human Services. The Bureau set up a Demographic Studies Center to handle some of the studies requested by other agencies. (A large portion of this work was originally funded by the Justice Department. That program was transferred to Justice and almost all of this work is now internally funded.)

Competition for Census support became intense. Congress added to this pressure by making Census data the basis for many federal programs, including General Revenue Sharing. As a result, Census was watched closely by state and local governments. Lawsuits brought by several cities accused the Bureau of undercounting population in those cities in 1980[17]. While the Bureau won the suits, the production of reports on the census was delayed.

Pressure also increased on Census to share its data with state and local agencies. In a case concerning undercounting of urban areas, the Courts upheld Census' refusal to turn over its records containing confidential information to local governments; the local governments had requested the records in order to do their own analysis of whether undercounting had occurred. Within the federal government, the Office of Management and Budget several times in the early 1980s sought greater sharing of Census data in order to reduce the cost of surveys and eliminate overlapping studies by different agencies[18]. The OMB proposals never came to fruition.

Census has become an international center for the development, testing, and dissemination of data and tools for demographic analyses. The Bureau provides training and consultation to foreign statisticians and census officials. The Bureau was as it is today the premier census organization in the world.

Audit and Monitoring

Census does two types of auditing and monitoring. First is administrative auditing — the traditional review of budgets, procedures, expenses, and other items. As noted above much of this was done manually in 1985 — especially in the field offices supporting the census efforts. Second, the Bureau audits the quality of the data it receives and disseminates. Proper design of questionnaires, data collection and capture, and analytical methods reduce error. The Bureau's Statistical Standards and Methodology area (SSM) was set up to develop, evaluate and foster the use of sound methods of gathering, processing, summarizing, and analyzing data. Given the specialized nature of much of the SSM work, it was often done outside the basic large mainframe based system of data processing. Instead, the area used labor intensive methods such as hand assembly of data, custom programming with batch processing, and hand preparation of final documents.

Personnel

The Bureau of the Census had 8,324 employees on December 31, 1984[19]. Of these 5,164 were full time employees, many of whom were assigned to clerical tasks related to the surveys, or the administration of the Bureau. A quarter of the 5,164 full time employees were professionals; the rest were managerial, administrative, clerical, or technical personnel.

The cyclical or episodic nature of the Bureau's work meant sizable fluctuations in employment. At the end of 1984, in addition to the 5,164 full time employees, the Bureau had 2,660 part time or intermittent employees. Of the part time employees, a number were permanent part time employees who worked on continuing surveys such as the Current Population Survey. The fluctuation in employment was especially great during census years. During the decennial census the Bureau could have as many as 300,000 people on the payroll.

Procurement/Support Services

As of 1984, procurement responsibility had shifted from the Department of Commerce to the Bureau of the Census. This was particularly important to the ability of the Bureau to keep abreast of technological developments. At the time there were proposals for automating much of the administration of the regional and central offices — administrative and clerical work was largely done with stand alone word processors in 1985. The regional and headquarters offices used Centrex systems and public phone lines for communications. Security was largely handled by making the buildings secure through guard stations and requiring building passes.

Planning

Planning remained manual in 1985. Scheduling and other aspects of tactical planning of censuses and surveys were done largely with conventional techniques. In some cases microcomputers using spreadsheet software were used to help organize these efforts. Overall operational and strategic planning used manually generated information because the data had not been entered into the computer system in support of a management information system. Developments in other areas such as the automation of data collection, data processing, and administration were seen as leading to the development of an effective management information system on which planning could be based.

In contrast to the general situation, the management information system (MIS) for the 1985 test censuses was automated with menu access and the automated MIS for the 1990 census was already in place.

INFORMATION TECHNOLOGY IN THE BUREAU OF THE CENSUS: 1991

This section discusses the changes in the use of information technology at the Bureau of the Census since 1985. At the beginning of this report, the key developments were highlighted. This section expands on those highlights. The discussion follows the same format as the 1985 discussion — beginning with the mission, moving to key information technology functions of information collection and analysis, information dissemination, and coordination and finishing with other functions — audit and monitoring, personnel, procurement and support services, and planning. These changes and the forces driving them are summarized in Exhibit 9.

Mission

The mission of the Bureau of the Census remained the same from 1985 to 1991. However, following the 1980 census, the many users of census data increased the pressure on the Bureau to make more data available and to make the available data more accurate, reliable, specific, and timely. These pressures were strongest from the rapidly growing field of commercial demographics. The spread of this industry has increased the demand for Census information of all kinds. As a result the workload of the Census has increased 100% in the past 5 years[20]. To reduce the burden of this increased workload, the Bureau has actively promoted its role as an advisor to the information collection efforts of other agencies. Also, in the spirit of the privatization trend begun in the 1980s, Census has contracted or subcontracted out several of the more routine, limited surveys such as the unemployment survey. The Bureau itself is the contractor to the Department of Labor for the Current Population Survey (unemployment survey). The decision to go "private" required approval by the Department of Labor.

Information Collection and Analysis

Information collection at Census has been revolutionized by technology. The evolution of computer technology coupled with the widespread dissatisfaction within Census and among census users with the antiquated methods of data collection led to a massive planning effort throughout the Bureau during the mid 1980s. This led to five major changes in information collection and analysis in both surveys and censuses: automated data collection, automated data entry, automated editing, the TIGER file, and distributed processing.[21]

The most significant change has been the move to automated data collection. The Census Bureau automated data entry in the 1990 Census, converting information on the questionnaire into machine readable form at the point of collection, much earlier than for previous censuses. The Bureau used a combination of data entry methods — FOSDIC, keying, and optical mark recognition. Optical mark recognition and optical character recognition technologies were used to enter data from 95% of the forms received during the census[23]. The use of computer assisted telephone interviewing (CATI), which was also being used in population and economic surveys, was introduced into the decennial census. CATI is a computer driven interview process involving automated data entry and on-line editing. These new data entry methods reduced the error rate from clerical and other non-sample sources. One consequence of the reduction of this error rate has been a shorter interval between the collection of the data and the production of reports and other policy relevant information.

During the late 1980s the Bureau developed an automated editing program using the principles of artificial intelligence and expert systems. Using an expert based algorithm, the automated editing program was able to check 100% of the questionnaires for consistency[24]. Early successes with smaller surveys led to expanding this program to the rest of the Bureau's surveys and censuses. Moreover, the overnight turnaround enabled enumerators to reinterview respondents with little additional cost. The Bureau is looking into expanding the editing program on CATI and into broadening the applications of expert systems at Census.

The fourth major innovation in information collection at Census is the completion of the automated geographic data file known as the Topologically Integrated Geographic Encoding Reference (TIGER) file[25]. With the assistance of the Global Positioning System (GPS) of the Navstar satellite network (resolution of 14 meters), TIGER enables Census to locate precisely addresses, political boundaries, and natural landmarks and to produce maps for census takers based on these files. More important, TIGER and the procedures for updating it when linked to the results of the censuses provide the capability for establishing a baseline picture of the economic and demographic state of the nation down to the lowest geographic level.

Census has moved from the large batch processing system of the 1980s to a multi-machine, interactive system in the 1990s[26]. The replacement of two Sperry 1100/84s and the Sperry 1100/62 with four Sperry 1101/90s — larger, more interactive mainframes -- reduced the competition for the computing resources of the Bureau. The addition of front end processors for load leveling and enhanced compatibilty with other machines has reduced the competition by encouraging the use of the wide range of microcomputers at Census as independent intelligent terminals. There are currently 2000 microcomputers in use at Census, or 0.85 microcomputers per Census Bureau professional employee[27]. The development of user friendly software for these microcomputers using Federal Information Processing Standard (FIPS) languages has furthered the shift from mainframes to microcomputers[28].

Information Dissemination

The near universal introduction of microcomputers into private sector offices and the growing demand for demographic and economic data for decisions on everything from building new shopping malls to siting hazardous waste dumps to selling toothpaste combine with the new software capabilities to create an eager, aggressive market for the results of Census operations. As a result the pressure to make data available sooner and at greater levels of detail continues to grow. Census has responded. Where in the 1980s it took 180 days from the receipt of data by an analyst to the production of a report, it now takes less than 60 days[29]. On average the reports of the 1990 Census were available in a third the time it took to prepare similar reports on the 1980 Census. On the level of detail available, Census has remained firm in its commitment to protect the confidentiality of respondents in the face of lawsuits and other challenges. At the same time it has made larger and larger samples of microdata available. It has been able to do so by using knowledge based algorithms to test for the possible release of confidential information from microdata samples.

A major factor in the growing commercial use of census data and software is the continued growth of the industry providing demographic services to companies in support of marketing, advertising, and planning. From 1986 to 1990, 38% of the new demographic software or analysis firms were started by former Census employees[30]. This has been an important means for transferring Census technology to the private sector.

Census has significantly upgraded the quality and accuracy of the reports, graphics, and maps it produces based on surveys and censuses. The widespread adoption of computer graphics for cartography and for graphics work has enhanced the appearance and value of Census reports. However, the cost of these reports continues to increase. Between 1988 and 1990, Census under OMB pressure attempted to move to totally paperless distribution of reports — through magnetic tape, diskettes, and other electronic means. There was sufficient negative public reaction to halt the program and to restore paper reports. However, more than 95% of Census information is transmitted to users in electronic form[31].

Following the success of CENDATA in the mid 1980s, Census developed the Public Users Data Base (PUDB)[32]. Individual, organizational, and corporate subscriptions to the PUDB have tripled each year for the past three years. In addition to offering much more data than CENDATA, PUDB provides free software for using the demographic and economic information provided by Census.

The State Data Centers begun in the 1970s remain a vital part of the Census dissemination effort. The number of affiliate centers has increased from 1,000 in 1985 to 5,000 in 1990[33]. Almost every one of the over 3,000 counties in the U.S has a data center, usually affiliated with the local library. Census data has become part of many high school and college courses from social studies to economics.

The sale of Census data on diskettes has been particularly brisk. The growth of the commercial use of demographic information, the growing use of Census data in education, and the widespread introduction of powerful microcomputers have made the diskettes among the U.S. Government's best selling products. Now census reports are routinely released in paper copy, tape form, diskette, and, recently, optical disk.

Coordination

Improved communications, increased interactive computer capabilities, and the growth of user friendly software for many Census applications has increased the coordination responsibilities of the

Bureau. In addition Congress has laid on responsiblity for new activities such as high technology censuses and surveys of alternative work and family arrangements. As part of the high technology survey, the Bureau counted the number of first, second, and third generation robots in use in the United States. The increase in grants to states and cities based on population also added to the Census workload. In the late 1980s several agencies sought OMB permission to establish their own in-house data processing capabilities which would use Census data to address their specific needs. These requests were denied on the basis of possible violations of Title 13, the U.S. Code which protects the confidentiality of Census data. As a result the computing capacity of the Bureau was signficantly enhanced by the addition of a fourth mainframe computer. Congress has ~~authorized~~ authorize Census to transfer some of the simpler, less complex surveys such as the Employment Survey to private contractors and to other agencies.

Census has become an international center for the development, testing, and dissemination of data and tools for demographic analyses. The declining cost and growing portability of microcomputers has led to a revolution in the methods of collecting and analyzing census data around the world. The Bureau has led the world in the development of user friendly software covering data entry, editing, tabulating, and other methods for analyzing census data[34]. The value of this software is its compatibility with a wide range of microcomputers. To assist census efforts in developing countries, Census offers low cost on site training courses and an international census software support center. In addition to software training and support, the Bureau has advised more than 75 countries in their census efforts. This advice ranges from brief on site meetings to frequent interaction with census officials. The result, according to the United Nations, has been an overall fourfold increase in the amount, accuracy, and timeliness of foreign census data -- data upon which many public and private decisions are based.

Audit and Monitoring

The decentralized procurement of information technology begun in the mid 1980s succeeded because of the move to more automated administrative processes, especially procurement and payroll. At first Census encountered substantial problems with OMB and GAO. However, with the passage of the Watchdog Control Act of 1987 micro-management by these organizations and the parent department was brought into line[35]. The automation of many procurement and payroll requests gives Census managers as well as Commerce, OMB, and GAO officials timely and accurate information on the movement of people, goods, and money throughout the Bureau. With such timely information and operational plans, Census was able to automate its offices with little of the disruption and cost overruns characteristic of other federal agencies' efforts in this area. For example, large procurement requests for information technology are automatically flagged by the system and brought to the attention of relevant managers. Supplies, reproduction, and other services are also monitored for unusual expenses.

In addition to monitoring administrative performance, Census has developed a premier capability in assuring the quality of its data. This quality assurance capability, represented by the Census Statistical Office[36], includes checks on the design of survey and census instruments, the capture of information from interviews, the processing of large data sets, the identification of non-sample sources of error, and the use of accurate and meaningful graphics and statistics. In the late 1980s, the then Integrated Statistical Laboratory established its own computing capability — a minicomputer capable of handling large data sets but able to operate in an interactive mode[37]. With this state of the art equipment, Census is able to attract some of the leading statistical researchers in the world as employees and as contract professionals. The Census Statistical Office and its sister branch the Center for Demographic Studies are rapidly becoming the premier survey research groups in the world. Many government agencies and private firms seek its assistance in handling difficult data collection, processing, and analysis tasks. To meet these growing demands the resources and people assigned to the Office have doubled while the overall employment in the Bureau has declined.

Employment[38]

The growing use of microcomputers and distributed processing has significantly altered employment at the Bureau:

- The automation of data collection and entry (see information collection below) has cut the field workforce by a half. Where the field personnel once accounted for two-thirds of the Census workforce, they now number less than half of the workforce.
- In 1985, 31% of the Bureau's workforce was part time or intermittent workers. The automation of many tasks has reduced the need for many of these part time workers; more of these tasks are done by full time professionals who are responsible for several different jobs. The number of part time and intermittent employees has gone down to 17% of the total workforce.
- At the same time, the Bureau has increased the number of professionals it engages on a contract basis. In order to attract top flight people, the Bureau uses contract arrangements to give these people more freedom than they would traditionally have as federal employees. This way they can supplement their incomes and serve the public interest. In addition to new hires, contracting is spreading to full time headquarters staff. Some professionals chose contract work because it gives them great flexibility in terms of when and where to work. Other staff have remained on salary but are on flexible schedules or work at home plans. In several highly

specialized areas such as artificial intelligence, Census must use contract work to marshall the expertise it could not afford otherwise. As a result of this increase in contract work, the focus of supervision has changed from hours worked to results produced.

- Many of the clerical and administrative tasks surrounding censuses and surveys have been replaced by automation. Employment has decreased at Census to below 5,000 employees. Over 45% of these employees are professionals. At the same time automation has substantially reduced the fluctuation in Bureau staffing. Bureau employment did not go over 200,000 for the 1990 census. Many of the people in abolished positions retired or left the Bureau. For those that stayed, the Bureau offered extensive retraining which focused on managing several different tasks at once. Overall, there are fewer but more interesting jobs in the Bureau.

The central point about the effects of information technology on the Bureau of the Census is that it has weathered the reductions and other difficulties of the transition to nearly paperless operations and has emerged as an interesting, innovative place to work — a place that can attract skilled people. According to OPM Annual Workplace Evaluation Survey 134, October 1989, Census rates among the top five agencies of government in terms of the satisfaction of its employees[39].

Procurement/Support Services

Internal Bureau coordination has improved dramatically with the introduction of extensive local area networks capable of voice and data transmission. The isolation that characterized the different program areas within the Bureau is a thing of the past. Access to data from the Jeffersonville Data Preparation Center has improved since Census acquired its own satellite data channel.

Information technology has increased the importance of security at Census. During the 1990 Census a large marketing firm got access to raw, confidential Census data. While the Bureau was able to apprehend the wrongdoers, there was substantial concern over how many cases of unauthorized access had gone undetected[40]. Security procedures have been increased at all facilities and on all communications lines between Census facilities. All sensitive traffic is encrypted.

Aside from the security issue, the two major changes in the administration of Census have been the automation of virtually every office and the movement to a nearly paperless administrative system. Since 1985, Census has spent over $10,000 (1985 constant dollars) per employee on information technologies — from stand alone word processing to high speed printers to local area networks to high resolution computer plotters to extensive user friendly software[41]. Computer equipment and supplies are available from any stockroom.

A central actor in the smooth transition to the automated office has been the Microcomputer Information Center. The Center gives Census employees the opportunity to test, evaluate, and exchange ideas on the best hardware and software for doing their job. Instead of imposing one arbitrary system from above, decisions on the appropriate directions for hardware and software purchases evolve from the experiences of the staff as reported by the Center.

Another important feature of the transition to an automated Bureau was the fact that the Bureau was responsible for its own procurement. In upgrading its computers in the early 1980s Census found that using lowest possible cost as the main criterion for information technologies procurement led in the long term to inability to meet changing function and staff needs. More recently in the transition to an automated Bureau, Census distributed primary responsibility for information technologies procurement to end users, creating greater freedom and flexibility in procurement. End users were encouraged to build state of the art capabilities and future system flexibility. Several years of this procurement process have shown that slightly higher initial costs lead in the long run to more efficient and effective Bureau operations.

With the regularization of liability and benefits policies under the Off-Site Employment Act of 1988 the percent of Bureau employees working at home tripled to a present level of 3% working 90% of the time at home; 28% work 20-90% of the time at home (average 34%)[42].

Planning

The Bureau's planning has become more timely and more efficient with the widescale introduction of information technology. The move to automated administration and to automated processing of the censuses has provided management with more and better information upon which to base its short term operational plans. The Bureau's management information system lies at the heart of the time and cost savings brought about by these new technologies. With improved information on the status of Census projects, management can manage the workforce needs of the Bureau by shifting program specialists as well as production personnel to the most pressing needs; in this way the Bureau has been able to avoid the wide swings in employment which characterized previous Census efforts. On the other hand, strategic planning has been complicated by the advent of information technology. With the growing demands for Census services, the need to keep on top of the latest information technology has become essential. However, such advances are inherently difficult to plan. Generally, the widespread use of microcomputers in the Bureau means more people know about and use Bureau plans in their work.

THE FUTURE OF INFORMATION TECHNOLOGY AT CENSUS: A LOOK TO 1995

While the Census Bureau has made significant strides since 1985, improvements are still needed. This section describes information technology related changes proposed for the next four years. As with the previous two sections, the discussion begins with the mission, moves to key information technology related functions -- information collection and analysis, information dissemination, and coordination -- then finishes with a discussion of other functions -- audit and monitoring, personnel, procurement and support services, and planning. These proposed changes are summarized in Exhibit 9.

Mission

Possibly the most significant practical change in the function of the Bureau is the possible shift to continual censuses or rolling censuses[43]. Several companies, professional, and business associations have proposed replacing five year and special censuses with private sector sample surveys. They argue that statistical tools and methods of eliminating non-sample bias have advanced to the point that it is not cost effective to count each person in the United States; revenue sharing and many other policies will not be affected by a move to sample surveys instead of censuses. They advocate turning census responsiblities over to the private sector. However, the Congress and the Courts agree that government must retain control of the collection of information in order to protect confidentiality and ensure impartiality. As a result of this controversy, the Bureau is looking into combining its automated cartographic data base with the results of the 1990 census to form a baseline for continual or rolling sample surveys of the country. These samples would update and maintain the baseline while providing the necessary policy information at a fraction of the cost of traditional censuses. This practice was endorsed by the Commission on the Future of the Census[44].

Information Collection and Analysis

With a move to the rolling census, most information collection would be done by increasingly automated telephone interviews supplemented by enumerators using Portable Data Recorders (PDRs). Whether or not the Bureau moves to the rolling census, the next step in data entry is to substitute voice recognition for keying in the entries on the PDRs. This would speed up the interviewing while reducing the error rate. To reduce the possibilities of lost data or garbled transmission, Census is currently experimenting with combining PDRs with cellular phone systems to instantaneously transmit data to processing centers for editing.

By 1995, there will be more than 3,000 microcomputers at Census; this will be 1.33 microcomputers per professional employee[45]. The effects of this proliferation of micros are already beginning to be felt. The move to micros was initially driven by the desire to escape dependence on the large batch processing of the mainframes. However, there have been growing demands for microcomputer access to mainframe capabilities now that such connections are easily made using the front end processors and the interactive mainframes. The result is a growing burden on the mainframes and increasing competition for mainframe resources. By 1995, the Bureau intends to add a fifth mainframe computer with more power -- a Cray VI ultracomputer[46]. Part of the computing power of this new machine will be used in development of expert systems for exploratory data analysis. Using such systems, Census hopes to be able to get more information from the data it collects.

Information Dissemination

The time between data collection and data availability will be cut to a matter of months within the next four years. If the Bureau moves to a rolling census, the possibility of real time availability of Census data increases.

The primary focus of Census attention in the next four years in this area will be improving software capabilities and decreasing the costs of its services. Software remains a key barrier to widespread use of Census computer products by people other than professional demographers. The Bureau is rapidly becoming overloaded with requests for assistance from people interested in using Census data but unable to use related software. Until recently, commercial software was too expensive for many potential small users. The recent announcement of an inexpensive line of demographic software packages may lead to a decrease in the burden on Census.

Coordination

The requests for Census assistance or services by other agencies will continue to grow. However, the desire for using Census microdata for many different purposes will also grow. While other agencies are unlikely to set up their own in house Census data processing centers, they will take on more analysis with their own growing use of microcomputers. The issue of how much microdata Census will be able to provide to these agencies while maintaining confidentiality will continue to plague the Administration and Congress.

On the international scene, Census will continue the development of software for census taking. The amount of consultation will also grow as Census acquires a dedicated satellite channel. There is some question about the possibility of Census Bureau audits of foreign census quality. As it stands now, such audits will only be undertaken within the strictest confidence. There is some concern among potential users of this audit service as to the security of Census operations. These concerns about security may constrain the future of the quality audits of foreign censuses.

Audit and Monitoring

By 1995, the automation of the Bureau's administration should result in a nearly paperless administrative system[47]. This system will be housed on a dedicated mainframe at the Suitland headquarters. The fully automated administrative system will further simplify the task of administrative and budgetary audits.

Recently, several firms advertised their services and products as approved by the Census Statistical Office. While Census was able to reduce the use of such an endorsement in advertisements and reports, the issue of using the Census capability for some form of survey certification of other agencies or firms has been raised in Congress, in the Executive Branch, and in various business and professional association meetings. A Census policy paper on the issue is in preparation.

Personnel

The number of Census employees will continue to decline as more functions are automated. Similarly the fluctuations in employment that have characterized the decennial and quinquennial censuses will also decline. The net effect will be more full time professional workers but fewer employees overall. The trend toward using contract professionals is likely to continue as competition for those with statistical, demographic, and information technology expertise continues. The two areas most likely to see growth in the next five years are the Census Statistical Office and the Demographic Studies Center. Movement to a rolling census would accelerate these trends toward a more stable, professional workforce at the Bureau.

Procurement/Support Services

Full automation of the administrative system of the Census Bureau will increase the efficiency and effectiveness of support services such as mail, supplies, and telecommunications. Maintenance of local area networks and of satellite channels within and outside the U.S. will be particularly important as the Bureau becomes more active in the international sphere.

Security will become even more important than it is now as more Census data will be in transit at any given time. The security implications of transmitting raw census data using cellular radio should be investigated. Also the Bureau will need to maintain vigilance in protecting the physical security of its facilities and the security of its telecommunications. Encryption should keep pace with technological capabilities for decoding.

Planning

The automation of administration and data collection will further the ability of Census managers to do real time tactical and operational planning. The need for such planning will increase as the Bureau uses fewer people to do more tasks. The introduction of a rolling census would accelerate the need for real time planning.

SECURITY, PRIVACY, AND PUBLIC INFORMATION IMPLICATIONS

The changes since 1985 and the proposed changes for 1995 will increase the ability of the Bureau to fulfill its mission. By keeping up with the state of the art, Census can provide its users with the best possible data. In addition to increasing efficiency and effectiveness, the changes in information technology will affect the relations between Census and the public. Specifically, these changes will have implications for security of Census operations, privacy, and for the provision of public information. Many of these implications have already been noted; this section summarizes them.

Security

These new collection and reference technologies offer great new capabilities for collecting accurate and timely data. They also raise several issues of security and confidentiality. The security of Census operations involving PDRs and CATI is much more complex than paper based systems. The use of TIGER along with census results could lead to breaches of confidentiality. For example in 1985 none of Census communications were encrypted; all enumerators and interviewers used public telephone lines. In 1988, a high school student tapped a Current Population Survey interview with his neighbors. The student was apprehended after he distributed the results on a computer bulletin board. The court, at the urging of the federal prosecutor, sentenced the youth to 11 months in jail[48]. After this security breach, all traffic was encrypted.

As the technology and processes of the census and surveys change, the need for new approaches and methods for protecting security and reliability increases. During the 1990 census, a splinter group of the Posse Comitatus jammed a district office to a regional office transmission of the results of questionnaires from 10,000 households. Fortunately, the records of all but 87 of these questionnaires were on file at the district center. The 87 were interviews that had been recorded on Portable Data Recorders whose disks had been erased after they had been logged onto the district office computer. Now Census offices are required to keep records of interviews for a minimum of four weeks[49].

The future of security at Census is currently under consideration by the Risk Analysis Group in the Office of the Director of the Census. Some Census managers are calling for the development of an information classification system along the lines of that used in the national security area. Others argue that such a system will impede the sharing of information among different departments and return the Bureau to the fragmented state of the early 1980s when there was little interaction among different divisions. Others argue that such a classification system cannot work in the face of today's multi-machine, distributed processing systems. Whatever the resolution of this issue, all observers agree that security and the public perception of security are essential to Census operations.

Privacy

Growing demands for highly specific information from the decennial census and the five year census on agriculture, manufacturing, business, and trade drive the concern over security. The Census Bureau collects personal information from every American. According to Title 13, United States Code, Census is required to keep this information confidential. Beyond the legal issue, cooperation with Census depends on the goodwill of U.S. citizens. Confidentiality is the cornerstone of that goodwill. Without it many people would not answer Census questionnaires or would give false information.

The problem of privacy and confidentiality became particularly prominent in the mid 1980s. A 1984 survey found that only 31% of the public said the Bureau kept its information confidential; 51% felt the Bureau shared confidential information. Almost one-third of Congresspersons and their staff felt Census shared confidential information. Whether respondents were referring to sharing of individual level data or not, it was clear the Bureau had at least a perception problem regarding its confidentiality practices[50].

To protect its reputation, the Bureau has consistently denied those requests which threaten the confidentiality of respondents[51]. In the case of Marbury Marketing vs U.S.(1987), a company claimed a right to raw Census data on the basis of the Freedom of Information Act. The case was decided in favor of the government. The confidentiality issue came up in another case, Grassick vs U.S. (1988). Gustave Grassick claimed injury based on an arrest resulting from computer matching involving Census data, IRS data, and the files of a private credit bureau. The case against the government was dismissed because the plaintiff could not prove that Census data had been used in computer matching.

While these cases were decided in favor of Census, the publicity surrounding them further weakened the reputation of the Bureau. To enhance its standing with the public, the Bureau has not increased the amount of microlevel data available since the late 1980s. It also set up a citizens advisory panel to review all requests for information from government and private sector organizations.
In many cases, such as IRS and HUD use of Census data, there are strong incentives to push the limits on confidentiality to apprehend scofflaws and miscreants. Such use of Census data would threaten the trust upon which the validity and reliability of Census data rests. This panel has consistently rebuffed the attempts of the Administration to increase government efficiency through the sharing of Census data.

One of the most difficult issues the panel has faced is the rise of group privacy rights movements. Recently, the Association of Armenian-Americans requested that aggregate data about Armenian-Americans be suppressed in order to protect them from harrassment by militant Turkish groups. Similarly, Vietnamese Americans have requested suppression of data about them in order to make it more difficult for the Communist government to find families of people in Vietnam. While the panel did not recommend the suppression of data, it did recommend the Census set up a formal review process to identify potential group concerns. Census is looking into the use of expert systems as a method for identifying such concerns.

As a result of the efforts of the citizens advisory panel and of a major public relations campaign prior to the 1990 census, the public confidence in Census has rebounded somewhat. In 1990, 53% of the public feels the Census keeps personal information confidential. Less than 22% of the public feels Census shares confidential information with other agencies or with businesses[52]. This rebound is a major accomplishment in the face of growing public skepticism about government use of information technology.

Public Information

With the move to more electronic dissemination of Census information and the growing costs of printed reports, a number of people raised the question of whether all citizens had equal access to Census data. The growth of the commercial demographics industry and the growing use of microtargeting strategies based on Census data further promoted the view that Census was becoming the handmaiden of big business.

The response of Census, described above, was to set up an on line Public Users Data Base. While this data base increased public access to census information, people still charged that it discriminated against those who did not own microcomputers. The same charge was leveled against the growing sale of Census data on diskettes[53]. The concern over equal access to Census data did not die down until recently. The near universal availability of microcomputers, the growth of the State Data Centers' services, the development of similar services at the county level data centers, and the availability of free software from Census for manipulating Census data defused the issue. Census also reversed its 1988 decision to go to paperless distribution of reports. While the costs of the Census reports remain prohibitive for many, each State and county/city level data center receives a full set of relevant printed documents at no cost. Overall, 99% of Census data is released to the public in electronic form[54].

CONCLUSION

The Bureau of the Census faced a crossroads in the mid 1980s as a result of information technology. These technologies which were increasing the efficiency and effectiveness of the Bureau were also threatening its credibility with the public. The growing lack of public faith in the Census Bureau threatened the ability to collect valid personal information upon which so many public decisions rest. With the reaffirmation of the Census mission by the Courts, Congress, and most recently by the public, Census faces new but less threatening issues. The important and urgent issues facing the Bureau of the Census in the next four years are much the same as those that faced the Bureau in 1985:

- The future of the decennial census
- Pressure to improve the timeliness of Census products
- Maintaining top quality staff
- Keeping up with changing technology
- Finding new and better ways to get Census data to more users
- Meeting the growing demands of public and private clients for timely, accurate, and tailored analyses.

These are the issues born of success — success in making the Bureau of the Census the premier statistical agency in the world.

Exhibit 9

INFORMATION TECHNOLOGY AT THE BUREAU OF THE CENSUS

1985, 1991, 1995

CATEGORY	1985	1991	1995	KEY FORCES
MISSION	Collect, tabulate, disseminate information on people and the economy; decennial and quinquennial censuses and surveys provide data for public/private decisions	Essentially the same as 1985; 100% increase in workload; more contracting out; more of an advisory role.	Possible shift to a rolling census. Shift to more surveys and fewer censuses to speed up delivery of information.	Growth of commercial use of demographic information; increasing computing power of microcomputers; growing public demand for timely information for decisions.
KEY I.T. FUNCTIONS Info. Collection and Analysis	Primary function: mail out/mail back forms, telephone interviewing; manual processing assisted by computers; 3 level geographic files; 3 Sperry mainframes, 700 terminals, 400-600 micros; primarily batch processing.	Revolutionized by technology 1. Automated data entry 2. OMR/OCR for 93% of forms 3. Editing by expert systems 4. TIGER - 100% coverage 5. Distributed processing 4 Sperry mainframes; 0.85 micros/professional	TIGER and 1990 census results create baseline for rolling census. PDR's and CATI used for all collection; Expert systems probe data for relationships; 1.33 micros/professional; micros create need for Cray VI	More powerful, lower cost micros; pressure to increase efficiency, reduce payroll, and increase effectiveness; dissatisfaction inside and outside Census with the quality and timeliness of data produced.
Information Dissemination	Paper and computer tape; state data ctrs.; some use of diskettes, CENDATA; microdata samples cover 90% of counties; 4 yrs. to release census reports.	Public Users Data Base replaces CENDATA - subscriptions triple each year; 5000 data centers; diskettes are best sellers; 1.2 yrs for census reports.	Better, less expensive software available; more data per diskette to work with more powerful micros; census reports available in 2 months.	Growth of commercial demographics industry; growing public familiarity with information technology.
Coordination	____ requests for special censuses; growth of Demographic Studies Center and international consultation	Additional surveys including high tech (robotics); increased international role; 75 countries advised.	Possible quality audits on foreign surveys. Continued growth of requests for special surveys.	Continued pressure to reduce federal spending and to increase efficiency and productivity; international spread of microcomputers.
OTHER FUNCTIONS Audit/Monitor	Conventional admin. audits; Statistical Standards and Methodology area uses manual and computer tools.	Automated auditing of payroll and procurement; employment doubles at Statistical Office	Nearly paperless administrative system; possible certification role for the Statistical Office.	Growing reliance on census information for public and private decisions; continued development of expert systems.
Personnel	8324 employees; 2160 part time or intermittent; 25% professional; gets as high as 300,000 during census.	Fewer employees; 45% workers professional; 200,000 for 1990 census; contract professionals in some areas.	Fewer employees; more full time professionals; Statistical Office and Demographic Studies Center grow.	Federal service becoming less attractive; more competition for top people; more flextime and flexplace.
Procurement/ Support	Procurement at Census level; stand alone word-processing; Centrex	Automated procurement and payroll systems; $10,000 per employee on OA; more work at home; PABX.	Increased attention to security; More efficient due to paperless system.	Continued pressure from users to keep up with technology.
Planning	Conventional/manual	Better more timely information for planning. Long term planning complicated by changing technology.	Real time tactical and operational planning for all phases of Census operations and administration.	Efficiency, productivity, concerns continue; growth of Census workload.
IMPLICATIONS Security	Controlled access to buildings; use public phone lines with no encryption	Increased attention due to breaches. All traffic encrypted.	Encryption and other security measures keep pace with changing technologies.	Increased technical capacity to penetrate security; growing value of Census data to many activities.
Privacy	Title 13 - data must be kept confidential; 51% feel Census shares data; pressures to share data with agencies.	Citizens panel formed; no matching; group privacy rights issues raised; 53% feel Census does not share.	Continued pressure to release microdata to other agencies and to public.	Ubiquity of information technology and the abuse of others will maintain public concerns over privacy.
Public Information	Concern over equity of access to Census data; 90% of data released on computer tape; mostly to businesses and governments.	Attempt to go paperless fails due to public reaction; Ubiquity of data centers defuses equity issue; 95% of data released electronically.	More micros in society, more data centers, better software for using Census data, and lower data and software costs continue to defuse the equity issue.	Spreading computer capabilities - technical and personal; rising publications costs; growing value of Census data to many activities.

REFERENCES

1. The name Sperry 1101/90 is fictional. We used it to indicate an upgrade of the current Sperry 1100/84. We assume the Bureau will continue to use Sperrys into the early 1990s since their ADP plans say they will; see Bureau of the Census, Department of Commerce Information Technology Planning System: Bureau of the Census, 1984. (mimeo) May 1984.

2. The Commission and its report are fictional. Some of these comments are based on the discussion at a workshop with Census personnel. Others are comments found in various commentaries on Census in hearings, editorials, and articles.

3. Computer Assisted Telephone Interviewing (CATI) is currently in the prototype stage at the Census Bureau; it has been tested recently in the field. See Information Technology Plan 1984 (see note 1 for full citation).

4. Portable Data Recorder is a fictional name for a device currently in the experimental phase. See Information Technology Plan 1984.

5. This percentage is an estimate based on our judgment of the most optimistic gains one could achieve by automation by 1991. For the 1980 census all reports were out in 4 years; for 1990 the reports should be out within 1.5 years, due to the implementation of expert system coding of sample data.

6. The Citizen's Security Act is the fictional pretext for these scenarios. See introduction to the scenarios for more detail.

7. These numbers come from Information Technology Plan 1984.

8. The following discussion is based on Robert Marx, "Developing an Integrated Cartographic/Geographic Data Base for the United States Bureau of the Census" (mimeo) 1984.

9. Ibid.

10. This estimate was derived from workshop discussions with Census Bureau personnel. We are solely responsible for the content of the scenario; workshop comments were only used as background.

11. The following discussion is based upon Information Technology Plan 1984.

12. The number of microcomputers officially at Census is taken from the Census Microcomputer Information Center Bulletin (September,

REFERENCES (continued)

1984). The estimate of personal micros in use is based on our assumption that many people prefer to use the same system that they have at home or that they brought their own micros in before the Bureau began to provide micros.

13. These figures come from Bureau of the Census, Data User News (March 1982).

14. See Harold Berenson, "Targeting with Microdata," American Demographics (June 1982).

15. These figures are from Cheryl Russell, "The Business of Demographics," Population Bulletin 39 (June 1984).

16. See Bureau of the Census, Methods and Materials of Demography. Vol. 1 (Washington: GPO, 1980).

17. See Bryant Robey, "The 1990 Census: A View from 1984," American Demographics (July 1984).

18. See David Burnham, "U.S. to Urge Census Bureau to Share Its Personal Data," New York Times (11/20/83).

19. These figures are from a telephone conversation with the Bureau of the Census Personnel Office.

20. This is a logical extrapolation of the increases of the past 10 years. The past increases were identified in the workshop with Census personnel.

21. All of these, with the exception of automated editing, are in Information Technology Plan 1984.

22. See note 4.

23. See Information Technology Plan 1984.

24. This is a logical extrapolation of the application of existing artificial intelligence capabilities.

25. See Marx, "Developing Integrated Data Base" (see note 8).

26. These changes are slight modifications of those discussed in Information Technology Plan 1984.

REFERENCES (continued)

27. This estimate is based on Ray Kline, "ADP Emerging from the Dark Ages," Government Computer News (October, 1984).

28. See Information Technology Plan 1984.

29. See note 5.

30. This figure is based on the judgment that more current federal employees will find private business more lucrative than government service, especially as retirement and other benefits are scaled down.

31. This is a reasonable estimate given the figures in note 13.

32. This is a fictional name for an expanded version of the Census on-line data service, currently called CENDATA.

33. This estimate of affiliate data centers is reasonable given the facts that there are 1,000 data centers now; there are over 3,000 counties; and there are many other cities, boroughs, and similar areas that will have the interest and capability to house such a center in 1991.

34. This is described in Information Technology Plan 1984.

35. This Act is fictional but plausible given the increasing competition between fiscal accountability and the need for agency flexibility to meet changing public and private demands. The current tendency toward micromanagement of agency behavior could result in extreme delays in meeting public needs.

36. The Census Statistics Office is fictitious.

37. These capabilities come from Information Technology Plan 1984.

38. This discussion is based on comments in the workshop with Census personnel.

39. See Robey, "The 1990 Census."

40. This is a fictional example to illustrate the vulnerability of current Census operations. These vulnerabilities are noted in Information Technology Plan 1984.

41. This is an extrapolation of figures contained in Information Technology Plan 1984.

REFERENCES (continued)

42. This is a fictional but plausible Act given the move to increased flextime and flexible careers and the growing use of personal computers.

43. The possibility of such a development was noted at the workshop with Census personnel. We elaborated on the concept to create what appears here.

44. See note 2.

45. This is a reasonable extrapolation given the growth noted in note 27.

46. The need for a new mainframe to handle microcomputer generated traffic was discussed in several articles in Government Computer News (December 1984).

47. See Information Technology Plan 1984.

48. This is a fictional example to illustrate the vulnerability of current Census operations. These vulnerabilities are noted in Information Technology Plan 1984.

49. This is a fictional example to illustrate the vulnerability of current Census operations. These vulnerabilities are noted in Information Technology Plan 1984.

50. Robey, "The 1990 Census."

51. These are fictional examples to illustrate the vulnerability of current Census operations. These vulnerabilities are noted in Information Technology Plan 1984.

52. These are plausible estimates of the change in public opinion given the figures cited in note 50.

53. See Robey, "The 1990 Census."

54. This is a plausible extrapolation given the figures cited in note 13.

CHAPTER IV

BIANNUAL REPORT TO CONGRESS ON INFORMATION TECHNOLOGIES AND GOVERNMENT

INTERNAL REVENUE SERVICE

January 15, 1991

HIGHLIGHTS

Information technologies have increased the efficiency of IRS operations. With the automation of labor-intensive functions such as returns processing and examinations, IRS has expanded analytical work in taxation statistics and modeling. More attention is paid to the delivery of quality taxpayer services such as multilingual, interactive computer advice, automated examinations, and complaint resolution. The following are highlights of the IRS of 1991:[1]

- The speed, accuracy and efficiency of returns processing have greatly improved. Optical character recognition accounted for early efficiency improvements; now most advances are coming from electronic filing. Over 35% of returns are filed electronically; this number is expected to double by 1995. Additionally, there has been a great reduction in the filing of returns due to the introduction of a return-free filing option. Turnaround time on returns processing, refunds, and taxpayer services has been greatly reduced.
- Information technologies have been instrumental in significantly reducing the tax gap. Better computer processing has allowed 100% internal matching of returns and information forms; improved discriminate function analysis; interactive assistance to produce more accurate returns; automatic electronic payments; and more effective and efficient examinations.
- Through administrative and communications automation, computerized processing and examinations, IRS has pared its staff from 88,000 to 65,000. Offices, services, and staff are more decentralized yet better coordinated.

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[1] Reference notes indicate sources of information or expanded discussion on the reasoning behind a projection or suggested change. All references and notes are compiled at the end of the text.

- Examinations are more effective and more efficient. The Automated Examination System (AES) has increased the number of examinations. Improvements need to be made in the taxpayer and examiner satisfaction with AES.
- The shift to electronic payments and refunds has been slower than anticipated, due to public concern about equitable treatment of returns.
- Optical storage technology has made IRS tax records management efficient and comprehensive. The low cost and size of optical data storage has allowed IRS to move data archiving in-house from the National Archives and Records Services.
- IRS has expanded its research and analytical work, using the improved taxation data available. The bulk of work has been in detailed analysis and presentation of taxpayer statistics for IRS and other government agencies. The second focus is modeling of macroeconomic and microeconomic impacts of economic policies, tax policies in particular.
- IRS databases now provide better security of access and privacy following several highly publicized attempts to breach security. Internal audit trails provide real-time electronic monitoring of access to and use of IRS data. Employee movement and computer use within IRS facilities are registered electronically.
- IRS use of data from the private sector and federal and state government agencies continues to raise public concerns about privacy. Public confidence in IRS operations sank to an all-time low in 1989-90 following media coverage of database matching between IRS and the Federal Bureau of Investigation, initiated by Congress in the interests of national security but later found to be unconstitutional.

The next four sections of this scenario describe the IRS in 1985, information-driven changes from 1985 to the present (1991), anticipated developments by 1995, and the consequences of these developments for security, privacy, and the provision of public information.

Exhibit 10

CONSEQUENCES OF INFORMATION TECHNOLOGIES FOR IRS: THE FIRST DECADE

Comments from a senior managers' retreat, November 1994*

- Our organizational efficiency and effectiveness have increased: productivity of employees has improved immensely; privacy concerns of taxpayers have been mitigated although not resolved totally; and tax dollars collected have increased dramatically relative to collections costs. However, voluntary compliance has not improved to the degree that a sophisticated system such as ours should promote — it can't change taxpayer attitudes.
- A complete restructuring of the way in which we secure tax information. This has reduced the need for federal resources in processing tax information by shifting the early stages of tax processing to the taxpayers and a restructured returns preparer industry.
- A tenfold reduction in the processing of paper and paper records by providing graphics oriented workstations to tax examiners in our service centers, and to our field personnel. Under this system, returns are maintained electronically and can be printed out in standard format when required.
- The federal deficit has been reduced through increased revenue collection. This has been accomplished through automation without an increase in total resource expenditures by IRS.
- Based on Congress' agreeing to the Service's proposal for a high technology "Tax System Redesign" we have moved beyond a "replacement system" environment to a modern tax administration in step with current technology and the private sector.
- The delivery of increased services, revenue collection, and material reduction of the tax gap and national debt to the point where governnment is a self-supporting enterprise as opposed to a burden on the backs of the American public.
- An improved decisionmaking process based on more thorough and accurate information being available to all employees. The IRS of 1995 is a highly effective organization that is a model of tax adminstration for all nations.
- The IRS has been able to significantly close the tax gap because Congress has permitted it to use state of the art technology. IRS has modernized its work processes and procedures to process all tax information available to it; free up staffing used in less productive work to be applied to higher priority work; and reduce the IRS workforce in consonance with the Administration and Congressional mandate to minimize public expenditures.

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*These comments draw upon a project workshop with senior IRS managers.

INFORMATION TECHNOLOGY IN THE IRS: 1985

Mission

The IRS mission is "...to encourage and achieve the highest possible degree of voluntary compliance with the tax laws and regulations and to conduct itself so as to warrant the highest degree of public confidence in the integrity and efficiency of the Service."

The IRS is primarily a collections agency for income, estate, employment, excise, and gift taxes. In the process of collecting revenues for government operations, it also collects and maintains a large amount of sensitive information on taxpayers, both individuals and corporations. This entails extensive information security and data processing support. It also disseminates information — assistance to taxpayers, and statistics and special data to other agencies. IRS also has enforcement and criminal investigation powers. It can place liens on real, personal, and financial property for unpaid taxes.

The IRS is decentralized. The bulk of the work is handled at the 63 District Offices and 10 Service Centers, coordinated by seven regional offices. The National Headquarters oversees policy and agency management rather than operations. The National Computer Center at Martinsburg, West Virginia does batch processing for the Service Centers and updates IRS national databases.

Information Collection and Analysis

IRS data collection and processing, as now, was divided into two broad areas, returns and information form processing, and computer and database services.

In 1985 the IRS processed 182 million income tax returns and supplements, 101 million of them from individuals.[1] The IRS also processed 680 million information returns, such as 1099 and W-2 forms, 387 million of them submitted on computer tape.[2] In 1982 84% of these were matched with individual returns to catch discrepancies and nonfiling. About 2.4 million returns were audited.[3]

Accurate and fair audits were based on the DIF (Discriminate Function) scoring system, run at Martinsburg to measure taxpayer compliance, and set examination thresholds. A random sample of

50,000 returns was pulled once every three years to calculate typical return profiles. The effectiveness of DIF was based on equitable examination and a high certainty of getting caught if you cheat; it successfully incorporated both of these with random pulling of returns and computer screening based on confidential DIF-calculated thresholds.

The IRS collected $712 billion in gross receipts in 1985.[4] Electronic payments were not yet in place. The average turnaround time on refunds was about eight weeks, although in 1985 the conversion to a new computer system slowed refund processing. Collection was already in the first stages of automation; computers were used to schedule and place phone calls to delinquent taxpayers. The calls themselves were handled by a human examiner. The new system cut the cost of closing a case almost in half. To assist collection, in some states lists of delinquent taxpayers could be checked against computerized lists from state employment offices, motor vehicle departments, voter registration, and property tax records.[5]

The success of voluntary compliance hinges on IRS's ability to ensure fair collections and examinations and maintain privacy of sensitive financial information. IRS linked an increase in external matching of taxpayer data in the mid-1980s to a decrease in compliance.[6] To maintain confidentiality, only selected data about individual taxpayers -- the minimum amount necessary and directly relevant to the IRS mission -- was entered into databases. IRS maintained that confidentiality necessitated this loss of information at the data entry stage. An additional approach involved physical and electronic segregation of databases.

Each of the 10 Service Centers maintained its own computer services and databases. In 1985 the IRS substantially upgraded its outdated computers at the ten Service Centers with Sperry Univac 1100 mainframes. Each Service Center could access the others only indirectly, by requesting data from the National Computer Center. IRS National Headquarters could not directly access Service Center data. The Integrated Data Retrieval System (IDRS) stored individual tax data. Although networking technology was available, portions of

IDRS were located around the country in the centers, accessible by all District Offices serviced by a particular Service Center but not from the National Headquarters. In the interests of confidentiality, no single comprehensive database on individuals was maintained. Databases were segregated both physically and by IRS function, some indexed by social security number and some by district location number.

In 1985 the National Archives and Records Service still archived most of IRS data as paper forms. The average cost of retrieving a form was 50 cents.[7]

IRS in 1985 was in final planning stages of the Tax System Redesign Project, scheduled to begin in 1990 to make computerized tax processing more cost-effective using state-of-the-art hardware, software database management, and data communications and security.[8]

Information Dissemination

The IRS designs, publishes, and disseminates tax forms and information publications. In 1985 IRS designed 375 forms and (through GPO) they printed 646 million 1040 forms, millions of other tax forms, and 15 million taxpayer assistance publications.[9] As critical to IRS' mission, these publications are distributed free by public and private institutions.

The IRS provides assistance over the phone and in person. In 1985 the IRS fielded 49 million phone calls[10], dealt with eight million in-person inquiries[11], and answered 119 thousand written inquiries[12]. This assistance is integral to IRS's role as service agency to the taxpayer.

Coordination

Despite pressures from Congress and government agencies for access to the extensive and accurate IRS databases, IRS limited its information services for other government agencies to those mandated by law. Because of the conflict with the need to assure privacy, each transfer of IRS data was approved only if it was statutorially required and would not compromise the overall confidentiality of IRS data collection. Data sharing with other agencies was strictly limited to tracking already identified or suspected federal offenders, such as child support evaders and delinquent student loans. The lack of a central IRS database indexed by individual name also hindered extensive data sharing.

State revenue collection policies and practice were not closely linked to the IRS. In some instances, state and local governments provided access to their resident databases to IRS. For instance, IRS had partial access to Texas databases on vehicle ownership, property taxes, and voter registration to look for potential non-filers. IRS had requested but was denied access to telephone and social security numbers, and date of birth information.

The IRS regularly exchanges data with about 60 treaty nations, usually to trace income tax evasion and avoid dual taxation. This exchange was nearly entirely manual, on paper and by mail.

Audit and Monitoring

Ongoing internal audit is and was essential to the security of IRS databases and operations. It protects the integrity of taxpayer information within IRS; and, conversely, guards IRS operations and DIF procedures against undue public disclosure. These needs in turn must be balanced against the privacy and civil liberties rights of IRS employees.

Automatic audit trails were used in Service Center databases; unauthorized use was reviewed the next day. Potential lengthy prison sentences for security breaches deterred abuse of taxpayer records. The outmoded IRS computer systems both helped and hampered auditing; many security concerns were effectively precluded by the lack of integration of microcomputers and processing and database mainframes; but the number and diversity of computers throughout IRS made complete and consistent auditing difficult.

Employer

IRS had 88,000 employees, most of them in Service Centers and district offices. They included tax-related professionals -- revenue agents, revenue officers, etc. — and support staff for returns processing and information. There were over 8000 seasonal employees; the tax assistance workforce doubled from 2500 to 5000 at tax time.[13]

Extensive management programs maintained the esprit de corps and offered continuing training. Managers were brought together at the regional and national level several times each year. Additional training emphasized security and information ethics issues.

Procurement and Support Services

Microcomputers were not integrated; office automation was separated from large data processing functions. Electronic mail was localized and fragmented by today's standards.

The disclosure and security division, as now, was responsible for physical (e.g. facility), data, and communications security. IRS workers at Service Centers were required to display ID cards at all times. The larger computer centers also had extensive physical protection.

Procurement of information services was slow because of the difficulty of ensuring integration while maintaining decentralized data and operations security. The ADP strategic plan included further decentralization and increased compatibility. The Automation Policy Board[14] managed the different branches of information services: support for OA and telecommunications, taxpayer and computer services, and human resources and information systems.

Planning

Planning was essentially manual, emphasizing the allocation of time and effort to yearly cycles of publications, returns processing, examinations, etc. Baseline estimates of tax revenue, audit thresholds, etc., relied upon the random sample of returns analyzed every three or four years under the DIF system. Longer term planning revolved around nationally coordinating transition to new computer systems and data protocols -- to ensure simultaneous, swift, and smooth conversion.

INFORMATION TECHNOLOGIES IN THE IRS: 1991

Mission

The fundamental mission of the IRS is unchanged in 1991: to encourage voluntary compliance under a secure tax administration system. The greatest policy influence has been the Taxpayers Rights Act of 1990, endorsed by 112 Congresspersons.[15] This bill, passed the session in which it was introduced, laid out principles on federal collection, use, and dissemination of taxpayer data. Key clauses specify limits on data sharing among agencies, segregation of IRS databases and database access. Although many specific policies will not take full effect until 1992, the bill has already affected IRS operations; details are discussed below in appropriate sections.

Other major effects of information technologies have been increased efficiency of returns processing and increased tax revenue compared to collections cost. Although privacy concerns have preserved multiple IRS databases, entry and sorting of data have been streamlined by knowledge-based data management systems. Information technologies have made feasible the use of IRS data for investigation of highly specific populations, causing Congressional and public debate over data sharing and targeted tax policies that culminated in the passage of the Taxpayers Rights Act. IRS has, however, expanded work in taxpayer statistics within the privacy guidelines of the Act.

Information Collection and Analysis

The continuing federal deficit and declining taxpayer compliance have shifted more resources within IRS towards identifying and resolving cases of nonfiling, tax evasion, and tax fraud. Further automation has increased the efficiency and reduced the error rate of returns processing and data entry.

Pressure to increase federal revenues and reduce federal labor costs has encouraged IRS to push for electronic payment of estimated and final taxes into a dedicated Treasury account. An automated financial system program was set up in 1988 to encourage electronic payments. A television and radio advertising campaign stressed the security and accuracy of electronic handling. Under this arrangement, at the time of filing an estimated tax form, a taxpayer indicates the accounts and amounts to be electronically debited. The program also entails automatic quarterly debiting of estimated tax payments. Articles in the Wall Street Journal, while generally applauding the government's catching up to the electronic age, have raised sensitive issues such as the impact of electronic payment and filing on chances of being audited, and differential internal matching and data sharing.

Improved interactive electronic filing offers efficiency improvements, but experiences with introducing these technologies argues for cautious consideration of overall impacts. A recent example was the class action suit filed against IRS by the Citizens for Financial Emancipation (CFE).[16] The suit followed the 1988 introduction of interactive 1040EZ electronic filing. This IRS service was first made available through certain banks and private tax preparation offices. Although many simple tax returns could be filed electronically, the novel interactive capability was available only for the 1040EZ form. The 1040EZ form was checked at the IRS receiving center for mathematical and tax schedule errors; the taxpayer was given the opportunity to correct any straightforward mistakes before authorizing the filing. The CFE suit charged that this service actually disguised selective auditing of the "unwired" citizen. The suit was dismissed as IRS could show that the front-end computer checking was identical for all forms. However, IRS put aside plans to integrate preliminary math checking and data entry following the suit. Other such incidents have encouraged IRS to maintain both hardware and software separation of processing and analysis.

Return-free filing has been available on a full-fledged national scale for one year, later than anticipated by IRS. The delay was due in part to the findings of extended tests of the system, which revealed taxpayer demand for detailed reporting and authorization and greater errors in overpaid and underpaid tax, although processing costs were reduced.

In 1990 the IRS processed 210 million tax returns, 99 million of them individual. The two biggest changes have been the reduced time and labor costs of returns processing and the growth in electronic filing. Internal matching with source information forms is near 100%, up from 87% in 1985. Automatic source matching has expanded to include not only W-2 forms but most 1099 interest and dividend payments, limited partnership returns, and insurance and health care company reports. Over 38% of all tax returns were filed electronically in 1990. The average turnaround time on refunds has decreased 40% since 1985, and for electronic payments and refunds has decreased by 69% to 2.4 weeks.

Optical scanning (optical character recognition, or OCR) has been the dominant factor in reducing returns processing time and cost. In 1985, the first generation OCR system used with specially designed 1040EZ forms could handle less than 10,000 characters per minute (cpm) with at best a 70% acceptance rate. In practice, tne rate was slower. Currently OCR can effectively reach 50,000 cpm with an acceptance rate of 88%.[17] The limiting factor is the mechanical devices needed to sort and move forms. Use of OCR has reduced manpower, increased input speeds, and decreased error rates. The current IRS goal is to eliminate redundant data entry by 1993; i.e., to have 100% of returns directly fed into IRS computers by combined OCR and electronic filing.

In 1985 a few high-return groups were targeted for external matching because they had high public visibility (e.g. lottery and gambling winners, through special source reporting forms) or could be easily identified (e.g. truck drivers, through highway use tax records, and medical professionals, through purchased commercial mail-order lists). Special interest groups are targeted in 1991 for IRS research and enforcement because of the greater ease of identifying them. The report of the citizen oversight committee set up in 1985 resulted in a permanent independent Taxpayer Information Ethics Commission and a subsidiary technical advisory group.

With personality research advances and the building of a substantial body of data on attitudinal and lifestyle profiles, it is becoming feasible to match corporate and commercial databases against IRS profiles of noncompliers. A recent IRS projection estimated that with this screen incorporated into DIF, revenue collections could increase by $1 billion. However, although within legal bounds, this would entail matching of data between several agencies, and the creation of detailed individual values profiles. No such proposals have yet been put forth.

In 1990 IRS began storing all new returns data on optical disks. Although the technology has been available for several years, the switch from hardcopy was slowed by the debate over the use of archive disks — which can be written to only once — and the new generation of erasable disks. Eventually arguments based on the cost savings of erasable (i.e. reusable) disks and capability to correct errors were superseded by arguments in favor of the apparent security of archive optical disks. The average disk can store 15 billion bytes of data — 4.5 million pages of text.[18] Optical storage has enabled IRS to shift its data storage from NARS to under its own roof. The cost of retrieving data has dropped by nearly 80% (amortizing the new hardware costs over their lifetime).

The use of knowledge-based data search and management systems has made possible the combination of secure, functionally separate databases with internal online availability to taxpayer data. This increased data availability has been balanced by real-time access control and monitoring.

Increased taxpayer satisfaction with the fairness of examinations has followed the shift to yearly recalculation of DIF formulas. The move was made not only to increase accuracy but to reduce the opportunity for security breaches. In 1987 a private tax preparation company was discovered to be using a software package that used public IRS annual statistics and a computer-modified test array of authentic returns to approximate the DIF formulas used the previous year. The damaging effect of such media-publicized events can be gauged by the public opinion polls which universally recorded an all-time low in public confidence in the integrity of IRS.

Information Dissemination

The dissemination activities of IRS have increased. More information is requested by more corporate and individual taxpayers; and more federal, state, and local government agencies use IRS statistics. Information requests by and exchange agreements with foreign countries have increased as more capital moves across international borders.

The information dissemination activities of IRS fall into two broad classes: taxpayer assistance and data sharing.

The biggest change in taxpayer assistance has been knowledge-based interactive computer assistance. The nationwide TaxHelp system[19] provides consistent service to taxpayers in all regions, building on the computer information assistance available in the early 1980s. Two tiers of assistance are available; a 800 number telephone system and a more extensive query and information publication service which is available by computer. In 1990, this system received 78 million queries. It handled 66% of these on its own and referred the rest to experts standing by.

All electronic publications and assistance are available in thirty-five languages, a service not economically possible when only printed publications were issued.

This system and the general pressure to reduce government costs resulted in the IRS cutting its taxpayer assistance workforce in half from 1985 to 1990. However, there were transition problems. In line with government cost reduction, IRS reduced its printing run on publications and priced access to and downloading of information publications at the lowest tier of standard NTIS electronic fees. A civil liberties group filed suit over the more extensive information available on IRS computer databases, charging unfair access on the basis that only those who could afford computers, connect and database charges were receiving appropriate service. A federal judge ruled that the opportunity for access was "fair and just," citing the precedent of telephone calls to IRS. The court also recommended that IRS continue free hardcopy distribution of all documents available electronically, a decision later embodied in the Taxpayer Rights Act. IRS also increased the number of people in the taxpayer assistance function, which had dwindled during the late 1980s.

In the first iteration of TaxHelp, electronic updates caused discrepancies between standard printed information publications and the electronic database information to be found under subject categories in TaxHelp. To ensure equity, electronic updates were restricted to one a year. This was followed by last year's National Taxpayers Alliance suit against IRS for withholding information. Although IRS won the suit, it has separated two classes of information; official tax information publications, available in print or electronically; and all other specialized or updated information, under a separate assistance office.

Under current IRS interpretation of the Taxpayer Rights Act, all nonverbal (written, printed, or electronic) assistance information given out by any IRS computer, publication, or person, in any form, is binding. The release of information is being reconsidered following the highly publicized tax disaster of last year; 6.2 million individual 1989 tax returns were calculated for taxpayers and processed by one of the western regional centers using an outdated tax rate file that had not been cleared from the computer directory. The error went unnoticed for months because cross-checking programs called up the same erroneous tax rate file. The resulting undercalculation of tax resulted in a total loss in revenue to the government of $2.4 billion. Since this IRS has shifted from using one central tax rate file; instead, each major computer system maintains a separate tax rate file which is constantly cross-checked against the regional master file, which in turn is compared daily to the national file.

The number and variety of commercial tax services has increased. The biggest change has been the proliferation of tax simulation software packages. Many investment and brokerage firms, following the lead of Sears, Roebuck, have offered free tax simulation to attract new investors. IRS and the National Association of Tax Return Preparers are currently discussing a certification program to help the taxpayer identify legitimate simulations. (The official IRS simulation service for individual taxpayers is operated only by IRS Taxpayer Assistance Division.)

National special interest groups have expanded their use of commercial and their own tax simulations to propose tax legislation or demonstrate the economic implications of regulatory proposals. IRS has been increasingly called upon by other government agencies to assess the accuracy of such special-purpose tax models. IRS experts consulted on 233 submissions for EPA alone last year.

Under the Taxpayers Rights Act, the results of IRS computer runs under different economic conditions, unemployment rates, etc. must be made available to the public. An early draft of the Taxpayers Rights Bill required that the models themselves be available; this was struck out by the full committee. In addition, all Congressional requests for partial or complete tax runs are public information.

Coordination

IRS works more closely with with OMB and Congress. Agency and Congressional reliance on sophisticated economic impact modeling has raised the demand for Treasury data and expertise. The special attractions of IRS data are its comprehensive nationwide coverage and its fine detail on economic statistics and trends.

Closer ties to states have come through IRS technology transfer. Although states maintain independent tax administrations, they have increasingly adopted IRS hardware and software. Alternative tax structure models and tax simulation packages have found a particularly wide market. Several state tax officers have spent training time at the IRS Office of Tax Planning's Taxation Modeling Group. In return, IRS has run the tax models of several states on its own national databases, expanding IRS's flexibility in exploring a wide range of tax administration options. For example, the California III tax code model makes innovative use of a gift tax structure which has since been explored as part of a IRS national model.

Congress has continued to wrestle with the conflict between efficiency and privacy at IRS. Congress has restricted any wholesale matching of data, but limited data sharing has continued, primarily to track already suspected citizens. However, more "special groups" have been targeted. By the time the Taxpayers Rights Act was passed, the detail and number of profiles conducted for IRS enforcement and for other agencies covered 30% of the returns filed. A few examples illustrate the range of this matching and profiling ranged from valuable to near-abuse:[20]

- NSA was authorized by Congress to use Commerce, ITA, and IRS data to investigate international movement of sensitive products and technologies.
- To look into food stamp abuse, Congress directed that microlevel Census, HHS, and IRS data be matched against food store records.
- The tax records of the leaders of 237 small religious organizations were opened to the Drug Enforcement Administration following the disclosure of Zoroastrian Revelation Harmonium involvement in a $25 million per year cocaine operation. This was made possible by Congress' altering the the tax law.
- EPA assessment of regulatory compliance with the Safe Drinking Water Act looked at IRS corporate accelerated depreciation forms for groundwater pollution control equipment.

Several bills introduced in Congress propose various strategies for requiring notification or disclosure to an individual at the time his name is placed on such a list or the list is made available to the IRS for matching purposes.

International activities have becomes more important. The U.S. and Canadian tax services are negotiating a special data link to assist both in corporate and individual tax evasion investigation. The final negotiations involve the technical details of mutually acceptable coding to prevent the disclosure of any identities.

Audit and Monitoring

In 1984, only a small amount of IRS data was encrypted (all national security data and about 10% of sensitive data).[21] Currently, all national security and all sensitive data is encrypted under DES standards. The amount of IRS data considered sensitive has doubled since 1985.

Encryption is used for data storage (when entered), data communications, and for portable computers carried by field agents. When new district level links were put in in 1989, specially designed fiber optics were justified to secure transmission.

All IRS employees wear ID cards that must be used to log on and log off computers, including standalone microcomputers and all terminals. The cards must also be inserted into entry points into and within facilities at Service Centers. ID card use provides statistics on movement, productivity, payroll, and database access. The location of personnel in the National Computing Center is monitored in real-time through ID cards. Biological identification (fingerprints, hand profile pattern matching, retina maps, speech recognition, and signature dynamics, and implants) are being discussed for workers with access to sensitive data and national databases.

Security and privacy of taxpayer data have continued to be paramount in internal IRS planning and operations. All IRS databases provide real-time notification of unauthorized access or alteration. During 1989, the first year of full operation of the computerized IRS database monitoring and alarm system, 19 unauthorized breaches of the first ring of taxpayer database security were tagged. The electronic trail created by the alarm system upon unauthorized entry into the databases tracked eight of the breaches to one disgruntled employee. The rest of the incidents were unresolved. However, in all cases no sensitive data was released. A Congressional investigation concluded that IRS' database security was, "first-rate, a model for other government agencies." In 1990 the rate of unauthorized database entry declined. Approximately 14% of the IRS information systems budget is reserved for hardware and software security measures.

Employer

With the assistance of portable computers more IRS employees are working from their home. A program to do some home-based data entry failed because of security problems. About 38% of revenue agents and 52% of revenue officers and special agents work from home.

Since the Automated Examinations System (AES) was fully implemented in 1989,[22] examiner turnover has increased. The first generation of equipment was laborious to operate; examiners complained that the standardized query tree reduced their role to that of a machine operator. Although average examination time has decreased with computerization of taxpayer records, the AES has itself not produced the anticipated savings in examiner efficiency. Unexpectedly, public opinion surveys reported less consumer satisfaction with the standardized examination — they did not trust the machines to "play fair." The AES update scheduled for later this year will provide greater flexibility for the examiner without sacrificing the standardized query tree.

With OCR, electronic filing, and direct entry from field examiners, the clerical staff for entry of returns and examination data has decreased. Total IRS employment has decreased to 69,000.

Because of the continuing pay gap between the federal government and the private sector, IRS has had difficulty maintaining a skilled and stable base of information technologies specialists. Such expertise is vital if IRS is to keep its information systems up to date and secure.

Procurement and Support Services

Integration of microcomputers through local area networks and value-added networks occurred through the late 1980s. Security and computer time problems arose during the transition. Main Service Center computers were finally linked directly to the National Computing Center once transmission and access security could be assured. Over the past two years, response time problems have been addressed through the upgrade to networks clustered around powerful new minicomputers. In late 1988, IRS made the decision to physically limit networking between operational units, following several security lapses. Thus, while nearly all IRS office have complete voice and digital internal networks, national networking from microcomputers is still limited.

The central procurement office has become more of a recordkeeper and resource bank than day-to-day manager. System security and access control are central to procurement.

Planning

IRS and Treasury are more active in government economic and tax policymaking. In the current atmosphere in Congress and the Administration, agencies have drawn back from earlier sharing of data for agency budget planning and government economic policy. The IRS provides less data access to other agencies than in the late 1980s, and provides more information services on a cost-recovery basis.

The media played a large role in this shift in attitude. Investigative reporters shifted their chase from government waste to government abuse of citizen privacy and civil liberties. (Membership in the American Civil Liberties Union has been rising at 4% a year, to 300,000 in 1990.[23])

Agencies exchange more information about the structure and content of databases, however, although not the actual data. GSA has encouraged the use of standardized data dictionaries and database formats, to reduce the cost of government database management and to ease interagency transfer of data where approved.

Within IRS, the availability of historical and current information has greatly improved planning. The biggest effects have been in operations. Examiners are better able to plan their schedules and have increased their individual efficiencies by 20% (in resolved examinations per week and in dollars per examination) with computers for routing, reminding, and dialup. In turn, managers can plan their needs farther into the future and with better accuracy. They can track closely the productivity of individual employees.

Information systems planning has been more difficult, though is still vastly improved over the 1980s. Although most planning is decentralized, the national office has assumed a greater role in long-range technical and human factor security planning.

INFORMATION TECHNOLOGIES IN THE IRS: 1995

Mission

The IRS mission in 1995 will still be to provide government revenue by ensuring compliance with federal tax laws. Although "voluntary compliance" will remain the byword, by 1995 the potential for complete internal matching of returns with source information, electronic funds transfer (EFT) networks, and near-complete computerization of even small-scale financial transaction records could make compliance a matter of automatic processing of taxpayer and IRS electronic records rather than a separate, voluntary filing.

By 1995 many of the significant changes in IRS operations -- electronic filing, return-free filing and computerized returns processing, OCR, optical data storage, automated examination (AES), and administrative automation -- will have moved through the transition phase of the late 1980s. As these technologies become commonplace they will change the flow of information and responsibility among taxpayer, employer and financial institutions, and government.

Continued reduction of the federal deficit and tax gap should allow IRS to improve the efficiency of services to taxpayers. With near-total automation of routine filing and payment, IRS will increasingly shift to overseeing data use and privacy, providing statistics, and analyzing tax policy. A decade of actual and planned changes relating to information technology are summarized in Exhibit 11.

Information Collection

Efficiency improvements beyond the early 1990s are likely to be slower and fraught with security problems. The biggest advances will have already been made through 1980s automation of returns processing and data storage. The logical next step is extending the local integration and partial national mainframe networking of 1991 to a completely integrated IRS. This will entail solving difficult security and privacy issues as access to data entry, storage, and manipulation are effectively consolidated.

Over the next several years IRS will be addressing the persistent problem of authenticating electronic tax returns. No complete equivalent of the signature has been developed. Current methods rely primarily on the taxpayer entering a personal identity number. Several trial programs include:[24]

- A notary program using biological identification of the fingerprint of IRS representatives. The IRS notary at bank or federal central electronic service centers will verify the identity of the taxpayer filing a return.
- Using IRS six-year taxpayer data archives, a knowledge-based interactive screening system will query the taxpayer on personal information. Failure to properly answer will prevent filing and access to taxpayer records and notify a IRS security officer.- This service will be available from all modem-equipped microcomputers and electronic service centers.
- Electronic signoff, where a signature entered on a screen with a light pen would be compared with the signature of record in IRS files. Significant discrepancies would close the communications link.

Electronic filing could increase to 75-80% by 1995. The total number of returns filed will be reduced if IRS meets its schedule of offering source-calculated return services for previous 1040 filers. The IRS would calculate and prepare income tax returns for individuals with total income subject to information reporting, such as salary/wage and dividend/interest income, eliminating filing for up to two-thirds of individual filers. Although taxpayer surveys are favorable, some citizens' groups are lobbying Congress to require that the taxpayer be given a final opportunity to review and authorize his return.

Filing from home computers should be commonplace by 1995; trial programs have been in operation in Seattle and Atlanta. IRS is seeking ways to eliminate all manual and redundant data entry. A penalty for paper filing has been discussed but appears unlikely.

Federal tax revenue collection should increase with electronic payments. Filing and payment errors should be reduced even further.

The goal for IRS database management in 1995 is to have all data linked through a central database. Access security will be maintained by identity coding, filing by function and record area rather than individual, and audit trails. Electronic audit trails will monitor all access to and updating of records, checking against normally scheduled operations and authorized examinations work. Keyboard monitoring at all IRS workstations will provide independent cross-checking.

IRS may move to continuous return filing by 1995. There are two separate proposals — one, continuous return filing with electronic payment four days per year; and second, continuous filing and payment. This would ease the fluctuating burden on IRS computer services and allow IRS to provide faster, better more reliable taxpayer service throughout the year. Novel software would need to be developed to coordinate and track returns.[25]

The increasing efforts of the IRS to tap the underground economy could be made easier with the proposed conversion to machine readable money. A 1989 IRS study estimated that there was $35-$45 billion in illegal income in the U.S., primarily from illegal drugs.[26] As the amount of circulating currency has declined, (down to $165 billion constant dollars from about $200 billion in 1985)[27], especially in larger ($50 and $100) denominations, the criminal share of larger denomination circulation has grown. Supported by the Federal Reserve, this argued for making all denominations larger than $50 machine readable. A citizen-government joint commission is considering the move. The commission's first report recommended that the threshold should be set at $100 to minimize the civil liberties implications for monitoring of individual citizen transactions. Optical scanners would be distributed first to major banks and within several years to all local banks.

Information Dissemination

Although electronic dissemination of tax information publications is expected to expand for the next five years, the rate of growth should slow. More IRS information publications and interactive assistance will be provided through automatic teller machines and federal electronic service centers. IRS will move to printing on demand of all forms now printed in less than ten million copies.

Several civil liberties groups have been lobbying for an individual's right of direct access to his own records in IRS and other government databases under the "freedom of access" clause of the Taxpayer Rights Act. Some observers believe the recent activism has been sparked by the move to return-free filing. IRS hopes by 1995 to make a separate taxpayer records database accessible online to individual and corporate taxpayers without compromising the security of internal working IRS databases. Because of freedom of information concerns, certain contents of his personal file but not the records themselves have been available to the taxpayer. The unresolved technical barrier to direct online access is eliminating all possibility of the taxpayer being able to make changes in his records or gain access to records other than his own.

By 1995 IRS should be able to code and aggregate taxpayer data to make secure microlevel data available for government and academic economic research. Economic models using 100% actual data should be more accurate. Such coding should encourage data sharing for statistical analysis. Political debates are likely to continue over the appropriate level of privacy in data sharing for identification of individuals or groups -- even for socially expedient purposes, such as identifying probable insurance or medical fraud.

Inexpensive individual tax simulation packages should be available to libraries and individuals. These modeling and optimization packages will combine powerful, easy-to-use alternative tax planning strategies with use of an individual's official IRS historical tax package as well as federal tax code and statistics.

Electronic payment of taxes and refunds will continue to rise. Refunds could be minimal because of better calculations by source, IRS, and taxpayer.

Coordination

Data sharing will be managed more carefully and with greater public oversight. The ethics commission has recommended independent, formal impact assessment of all standing data sharing agreements and any large ad hoc interagency arrangement. With the reduction of the federal deficit and major efficiency gains from computerization, future information systems planning should increasingly emphasize privacy and security improvements.

U.S. tax policies and statistics will become more important to the planning of foreign governments and multinationals. Consequently, the federal government as well as U.S.-based corporations could become more concerned about the security implications of international transfer of IRS data. Technical and policy measures will be needed to avoid compromising taxpayer or national security. The possibility of malicious release of an electronic tapeworm into IRS computer systems also argues for greater restraint on external data exchange. The threat is real; the past several years have seen a record number of cases of industrial electronic sabotage, despite protection measures and stiffly enforced jail sentences and penalties.

Audit and Monitoring

The greatest efforts over the next five years are likely to come in employee security and monitoring of IRS computer and data use. Although the use of personal ID cards for building and computer access have improved security, further improvments are possible and desirable. Over the next few years, all employees will be required to submit their ID cards weekly or monthly to check the card's memory record of the employee's activities.

Advances in biological identification should make noninvasive security checks — fingerprint, retina, and/or immunoprofile scans — feasible for employees with central computer access. Successful use of these procedures, being investigated by Department of Defense, should eliminate the need for such controversial identification measures as implants.

By 1995 a new generation of office and interoffice networking should greatly reduce the paper and magnetic tape burden of administration. The administrative computer system will allow closer review of contract progress and compliance. Monitoring and reporting requirements for off-site workers will need to be reviewed.

Employer

IRS employment is projected to decrease further with expanding electronic filing and payments. More IRS employees will work off-site and part-time. Most of these will be taxpayer and filing assistance workers, at banks and sites of federal electronic service centers. By the late 1990s, however, as electronic filing becomes the norm rather than the exception, it is expected that more IRS taxpayer assistance will be coordinated through online query networks. This will eventually reduce the total need for assistance staff and allow taxpayer specialist advisers to work independent of location.

Following the success of the private sector, the IRS plans to expand personality and psychological screening before hiring and promotion. Public acceptance of such profiling has increased with the accumulating experience in the importance and predictability of the human role in computer security. In compliance with Federal Employee Principles, test results are made available to employees upon request.

Procurement/Support Services

By 1995, all IRS offices across the nation should have access to rapid, secure, integrated communications. Administrative computer services will continue to be separate from parallel taxpayer databases and data management networks. Links between the two will be made only through intermediate, independent nexus channels. Nationwide electronic mail will handle voice, graphics, text, and data.

An innovative taxpayer complaint resolution process using videoconferencing is planned by the enforcement division. The bulk of the use is expected to be during corporate taxpayer negotiations. Individual taxpayer complaints will be addressed the next day and resolved the same week.

Planning

Operations and information systems planning will be further disaggregated by 1995. Computer modeling using a complete database of U.S. tax records will allow more accurate longer-range forecasts at the national level and more real-time planning at the regional and district level.

ISSUES IN SECURITY, PRIVACY, AND PUBLIC INFORMATION

There are two key aspects of IRS information which accentuate security and privacy concerns: it is sensitive financial information, critical to businesses and individuals; and it cumulatively draws a finely detailed portrait of the lifestyle and microeconomic behavior of taxpayers. Together these aspects make the privacy and security of IRS information the essential foundation of voluntary compliance. At the same time, however, they make IRS information uniquely valuable to other interests. IRS information encompasses close to the entire population and corporations of the United States. And the financial bottleneck of taxpayer returns provide a concise record of the movement of money in the economy. Information technologies are powerful tools, whether used in manipulating this information in constructive or unintended ways, to breach private records, or to protect sensitive data. IRS will face new and important issues in privacy, security, and provision of public information as it acquires these powerful technologies. These are discussed below.

The Freedom of Information Act is but one part of a continuing emphasis on access to personal records, whether held by an employer or the government. "Freedom of access" is broadening to include knowledge of all use of personal records. IRS must provide access to such personal data while at the same time ensuring total privacy from access to that data by any other persons or unauthorized IRS employees. IRS has already established a policy of access only to the contents and not to the databases themselves. As IRS and other agency databases are improved for more efficient entry, updating, and access from remote sites, it will become more critical to maintain both the integrity of and authorized access to taxpayer records.

IRS will need to continue to address the difficulty of preventing employee abuse of taxpayer information without themselves abusing the civil rights of the employees. Deterrents range from physical and software barriers to the legal and moral. The Computer

Fraud and Abuse Act of 1984 targeted federal information security, made breaking in to use or modify unclassified information a misdemeanor[28]. Identity cards must be displayed by employees. IRS also trains new employees in information security issues. Further methods become more intrusive -- individual surveillance with ID cards which record movement and productivity; biological identification and monitoring with implants. Psychological evaluation and screening should improve the security of IRS employees but could trespass upon their rights.

The need for privacy and security of IRS data must continually be traded off against the usefulness of that data for non-IRS purposes. Data sharing can range from the tracking of specific, known criminals, to searching for a small set of suspected child support evaders, to wholesale matching of national IRS and Social Security Administration databases. Data sharing within the government is more restricted than in the private sector. What is an individual's right to privacy of his own data when that data may help provide information on criminals?

One means to use taxpayer data and still maintain privacy is through coding or aggregation of individual data packages. Coded individual tax records can be valuable for economic modeling and impact analysis, IRS statistics, market research, demographic analysis, etc., by both the private sector and government. What level of aggregation will ensure appropriate anonymity for small groups? IRS has maintained indexing by social security number rather than name.

Equity of taxpayer treatment by IRS will come into question as IRS shifts more and more to information technologies. As more assistance and information publications are provided electronically, the equal access to these services becomes more important and potentially more divisive. Will the same quality of service be offered by traditional and electronic routes? Will treatment of electronic filing and payment be equitable, especially during the transition to new technologies? Differential treatment of taxpayers for examinations, internal and external matching, and investigations will be even more controversial. Commercial and government databases could make it easier to target individuals or groups who have the best-established electronic records; e.g., those in cities, who own cars, have multiple credit records, etc.

Information stored and available on the computers of income sources can generate a detailed financial profile of a taxpayer which can be compared with the taxpayer's return. Eventually this could obviate the need for some taxpayers to file a return. In the nearer term this allows IRS to match return against source information. It is likely that such cross-checking will reveal more intentional and unintentional discrepancies. This in turn will increase the need to set thresholds and priorities for examination. The burden of returns pulled for auditing under the discriminate function system (DIF) already exceeds IRS examination resources. With more detailed information available, more overt policy decisions will need to be made about how IRS resources are allotted to examinations.

Computer modeling with the riches of IRS data will reveal in unprecedented detail the social impacts of proposed economic policies and tax code changes. This offers benefits by helping to assess the efficacy of proposed tax strategies, to search for unanticipated and undesirable impacts. However, it also provides a tool for intense scrutiny of policy. These data handling tools allow targeting of social or economic groups for select tax treatment. Policy decisions will be intensely scrutinized by special interest groups. The fine detail available will force the policymaker into the spotlight where many more overt decisions could be made.

The broad issue of verification and legal admissibility of electronic records will be increasingly important to IRS. As more taxpayer data is stored optically, the initial entry, updates, and usage will need to be explicitly verified. Optical facsimiles will need to be usable in place of paper forms.

Exhibit 11

INFORMATION TECHNOLOGY AT THE INTERNAL REVENUE SERVICE

1985, 1991, 1995

CATEGORY	1985	1991	1995	KEY FORCES
MISSION	"..to encourage and achieve the highest possible degree of voluntary compliance with the tax laws..."	With same mission, more emphasis on research, investigations, oversight of use of IRS data. Taxpayers Rights Bill.	Same central mission; possible move to rolling filing. Some source-based filing.	Increasing automation of financial records, filing, payment. Rising demand for individual level economic data.
KEY IT FUNCTIONS				
Info Collection and Analysis	Returns and information forms processing 98% by manual reentry of return data. Trial OCR. Hardcopy filing, payment, and archiving. Limited internal matching for errors and DIF calcuation. Segregated regional databases.	Large efficiency and speed increases, cost decreases: OCR up to 70%, electronic filing 38%. Six-year in-house archiving on optical disk. Complete internal matching for errors. Regional databases.	Interactive multiyear tax simulation with IRS or private software. Complete statistical analysis of all returns. Electronic payment, refunds through ATMs. Protected database indexing.	Spread of micros, EFT and computerized financial records. Pressure to reduce cost, labor within government. Need to collect more information for national economic planning.
Information Dissemination	One billion forms and information publications printed each year. Trial. online publications. Phone, Teletax help. Aggregated tax statistics released yearly.	Interactive computerized taxpayer assistance. Electronic publications. Certification of private services, databases. Restrictions on data sharing following abuses.	IRS tax planning software sold. Refund turnaround time under two weeks. Privatization of tax assistance. Read-only access to your tax records.	Public pressure for equitable information access. Growth of commercial databases, value added services. Demand for secure data handling.
Coordination	Limited sharing of data with agencies to target criminals. State data used to seek nonfilers. Data exchange with treaty nations.	Increased data sharing with states, other agencies. Greater role in economic, tax policy. More statistics research Int'l business exchange.	Development of aggregated data for private sector, government statistical analysis. Expanded international cooperation.	Demand for microlevel economic, social data. Internationalization of economies, businesses.
Regulation/ Enforcement	Computers used to dial and schedule collections phone calls. Seizure of assets after warnings.	Improved efficiency; higher percentage of tax due collected.	Machine readable money to track criminals. Access to credit, financial records.	Ability to access and match databases. Growing computer financial crime, EFT.
OTHER FUNCTIONS				
Audit/Monitoring	Automatic audit trails in databases with next-day investigation. Oversight of data use.	Extensive encryption of sensitive data and all transmissions. ID needed for computer access.	Real-time computer auditing of all databases and transmission both access and use.	Improved database security, encryption. Need to ensure security and privacy.
Personnel	Extensive data entry in returns processing. 88,000 employees; 5000 seasonal. Decentralized.	Examiners working from home, using AES. Reduction in seasonal, data entry staff.	Fewer employees; more in research, modeling. Psychological screening of some staff.	Increasing automation. Security concerns. More interest in flextime, flexplace.
Procurement/ Support	Limited local integration of electronic mail, microcomputers. Personal ID cards required.	Integration with LANs. Continued limits on interregional networking after security lapses.	Discussion of subdermal implants for central database staff. Disaggregated procurement.	Need to match commercial technology for communications, security.
Planning	Conventional/manual.	More efficient planning by computer scheduling. Greater role in national economic planning.	Near real-time monitoring of returns, payments, collections.	Continued pressure to increase revenue, reduce expenses, and ensure data privacy.
IMPLICATIONS				
Security	Controlled access to buildings and computer facilities. Limits on data transmission.	More encryption. Real-time monitoring of data, employees. Self-contained AI database management.	Controlled access to databases. More AI-based database security One-time optical disks.	Increased technical capability to penetrate security; growing value of microdata.
Privacy	Pressure to share data with agencies. Limited data entry and archiving. No indexing by name.	Segregated databases. Media exposes of data sharing. Microdemographic analysis possible.	Aggregation and coding of data before external sharing or publication.	Ability to identify and target specific groups. Abuse of data sharing.
Public Information	Extensive information and assistance services. Oversight of data sharing	Paper duplication of electronic publications. All data sharing, tax modeling public info.	One-way taxpayer access to IRS records. Certification of private tax services.	Rising cost of paper and electronic information. Ability to interactively simulate tax.

REFERENCES

1. Extrapolated from 171.2 million total and 95.4 million individual returns in 1983 (*Wall Street Journal*).
2. Extrapolated from 1981 figures of 645 million total and 336 million on magnetic tape (J. W. Wade, *When You Owe the IRS*, London: Collier Macmillan, 1983.)
3. In 1981 the IRS audited 1.93 million returns (*Wall Street Journal*); at a project workshop an IRS manager estimated that 2.2 million returns were examined, of 5 million pulled for examination.
4. Extrapolated from $672.2 billion in 1983 (*Wall Street Journal*), and $606.8 billion in 1981 (Wade) (real dollars).
5. David Burnham, "21 I.R.S Computer Centers Uncover Nonpayers," *New York Times*, April 14, 1985, p. 30.
6. Project-related workshop with senior IRS managers.
7. From IRS film 7313-V16, "Design for Tomorrow," October 1984.
8. The Tax System Redesign project (TSR) is an existing IRS plan, scheduled to start operation in 1990. Its broad scope includes bringing archived data in-house from NARS, improved database security, a move from batch to online access, and security, and centralized management of all tax data through the application of articificial intelligence principles.
9. Extrapolated from 13 million in 1981 (Wade).
10. Extrapolated from 42 million in 1983 (WSJ) and 36 million in 1981 (Wade).
11. Extrapolated from 8.7 million in 1981 (Wade).
12. Extrapolated from 102 thousand in 1981 (Wade).
13. Wade, 1981.
14. A real IRS entity.
15. This bill is an imaginary vehicle to express taxpayer and Congressional concerns over public access, privacy, and civil liberties following IRS' adoption of new generations of information technologies.

REFERENCES (cont.)

16. CFE is an imaginary organization whose charter dedicated it to "...the preservation of freedom and equal financial opportunity for those citizens who maintain independence from institutional electronic control of individual monies and assets."

17. U.S. Department of Treasury, "Technology Trends and Forecast," July 1984, p. 40.

18. U.S. Department of Treasury, "Technology Trends and Forecast," July 1984, p. 8.

19. TaxHelp is imaginary but the trends and technologies are not. The existing computer information assistance provides limited assistance over the phone, from recorded information to allowing taxpayers to trace the status of refunds by touch tone input to an interactive computer system. Improved taxpayer assistance is a target of IRS information technologies, especially interactive knowledge-based systems.

20. All these cases are imaginary; they are included to suggest the wide range of possible applications of IRS data.

21. U.S. Department of Treasury, "Technology Trends and Forecasts," July 1984, p. 29. "'Sensitive data' is information which, if intentionally or unintentionally disclosed, could involve the loss of life, monies, or privacy. 'National Security' information (confidential, secret, top secret, and beyond) protection requirements need NSA approval.."

22. AES is real, scheduled by IRS to be fully operational in 1989.

23. Estimates provided over the phone by the ACLU National Office, New York. Membership in 1984 was approximately 250,000.

24. These are real possibilities under consideration by the IRS. As yet they are only concepts.

25. Continuous filing has been under discussion by IRS and the private sector. No specific proposals have been put forth.

26. A real 1979 IRS study estimated $25-35 billion in illegal income.

27. This assumes a constant dollar decrease in the amount of currency in circulation of about 5% per year, partly offset by low to moderate inflation.

28. Mitch Betts, "DP worker charged with hacking," ComputerWorld, 11 Feburary 1985, p. 2.

CHAPTER V

BIANNUAL REPORT TO CONGRESS ON INFORMATION TECHNOLOGY AND GOVERNMENT
ENVIRONMENTAL PROTECTION AGENCY
JANUARY 15, 1991

HIGHLIGHTS

The last ten years have changed the outlook, organization, and operation of the Environmental Protection Agency (EPA). A headquarters oriented agency organized primarily on media such as air, water, and land has become regionally and state oriented and focused on integrated strategies reducing environmental risks across all media. The states, once resistant and ineffective in husbanding the environment, today are dynamic, innovative, and effective protectors of the environment. Voluntary compliance with environmental regulations has improved as negotiated rule making and enforcement have increased. EPA research, regulation, and data collection have shifted more and more to the health effects of pollution. Important new health effects have complemented the continuing concern for carcinogenesis, mutagenesis, and teratogenesis, harmful as they are; among these are effects on brain function, immunological competence, and aging.

Information technologies have been important and occasionally essential to these many changes. A regionally oriented EPA emphasizing health risks and pollutants across all media is the outcome of forces at work for well over a decade and came from a variety of sources: the New Federalism of the Reagan Administration which accelerated trends already at work in the Carter years; the demands of state and local environmental officials; and the pressing concerns of groups such as Public Citizen and the Natural Resources Defense Council. The physical instruments to transform the agency were the emerging technologies of computers, telecommunications, database management, microprocesser-based monitoring, remote sensing, and artificial intelligence. Incremental procurement directed by an upgrading strategy helped keep EPA close to the forefront of technological change while continuing to meet its many statutory responsibilities faster and more fully. There are many areas in need of continued improvement — database integration, data quality assurance, public access to environmental information, and more efficient computing and telecommuications as needs, opportunities and competence each move ahead.

EPA plans major improvements in each of these areas by 1995. Before turning to the future, let us review the specific information technology-related changes EPA has seen in the last decade:

- Implementation of the logical mainframe concept involving an IBM 3090 mainframe connected to regional compatible processors using identical software environments and connected through System Network Architecture telecommunications system. Today there is a terminal, personal computer, or electronic workstation for every employee in EPA.(1)*
- Integration of the major media databases under Aerometric Information and Retrieval System (AIRS), Water Quality Storage and Retrival System (STORET), and the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS).(2) All of these databases use ADABAS -- the official EPA database management system.(3)
- Direct, automated environmental and enforcement data reporting by between 33 and 44 states depending on the program.
- Improved, less expensive monitoring of the environment and individual exposure using miniature electronic monitors and smart card based sensing systems. These monitors have led to an unprecedented improvement in the quality of environmental models used by EPA, other federal agencies, and state and local governments.
- Use of computer-based expert systems, most prominently in remote sensing of hazardous waste facilites, Environmental Impact Statement (EIS) reviews, and data quality assurance.

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* References are at the back of the scenario, These references give the source for, the logic behind, or the explanation of the specific illustrations, projections, or assumptions included in the scenario.

- Negotiated rule making involving key affected groups, facilitated by automated small group techniques such as Consensor and electronically assisted policy capturing of variables and conflict resolution techniques.
- More public access, as indicated by public access periods and commercial environmental software using EPA models.

With the new information technologies EPA has been able to meet its many legislative mandates in reporting, review, analysis, and public information. It also has a new sense of purpose, innovation, and accomplishment among the agency staff. In preparing this report, we put a query on EPASK(4), the EPA electronic billboard, asking EPA staff to identify the most significant effects of information technology on EPA over the past decade.

Exhibit 12 summarizes responses to our query. The message is clear — information technology has helped make EPA a better organization.

In the next four years:

- All states will report directly to EPA computers and will be linked directly to each other via EnviroNet.(5)
- EPA will begin to use satellites for remote sensing in support of enforcement and data quality assurance.
- An ecological database NEMIS combining STORET, CERCLIS, AIRS, and the Census Bureau's Topographically Integrated Geographic Encoding Reference File will further enable EPA to reduce environmental risks.(6)
- Robots for planting, repairing, and reprocessing environmental monitors and improved smart cards with embedded reprogrammable dosimeters will be in use.
- EPA will add another mainframe in the 3090 class.

Exhibit 12

EFFECTS OF INFORMATION TECHNOLOGY ON EPA: EPASK STAFF COMMENTS(7)

- The time necessary for major environmental health decisions has been reduced to 30% of what it was a decade ago. As important, the understanding of the implications of those decisions are better understood by orders of magnitude.
- Our staff is more productive through use of office automation technology (i.e. workstations, word processing, electronic/voice mail) coupled with improved communication. We're doing more and doing it faster than in 1985.
- More accurate data, better and more management alternatives, and more timely testing, evaluation, and distribution of data.
- Better access to all data throughout EPA decisionmaking and hence consolidation of multimedia impacts, and better coordination with various agencies and the public.
- A flattening of the organizational structure and hence more information for senior management in decisionmaking.
- Greater opportunity for fraud in EPA procurement process.
- Had not adequately prepared workforce to use the technology.
- Better relations with state counterparts and better state management because EPA can more effectively oversee state management and more quickly exchange more accurate data.
- More opportunities for clerical staff as routine jobs decline.
- Reduction of storage requirements for paper and fast deletion of unnecessary data.
- Location of word processing and analytical capability with each employee and reduction of clerical staff size.
- Decentralized data collection function; only key data elements come to Washington. Most data collection is done at the state level where it is used for day to day management work.
- Cost is the same as 1985 but the utility of the data has increased.
- Savings to the regulated community and the public because we can document costs and benefits with much greater specificity.

The next four sections elaborate on these highlights by describing the information technology at EPA in 1985, the developments from 1985 to 1991, developments anticipated by 1995, and finally the specific consequences for security, privacy, and the provision of public information.

INFORMATION TECHNOLOGY IN THE ENVIRONMENTAL PROTECTION AGENCY: 1985

Public Law 100-16, the Citizens Security Act, requires each agency to report on the effects of developments in information technology on its functions since 1985. To provide perspective on the changes wrought by information technology this section describes the use of information technology at EPA in 1985. The discussion uses the functional categories outlined in the Citizens Security Act. After stating the mission of the Environmental Protection Agency, the discussion turns to those functions for which information technology has the most direct and planned significance: information collection and analysis, coordination, regulation, and information dissemination. The discussion then covers other agency functions: planning, personnel, support services, procurement, and auditing.

Mission

The mission of the Environmental Protection Agency in 1985, as it is today, was to coordinate effective governmental action on behalf of the environment. Specifically, EPA spearheaded governmental attention to many areas of environmental concern including:

- Air - stationary sources and vehicle emissions;
- Water - surface and groundwater quality, wastewater treatment, drinking water supply, and controlling effluents;
- Solid Waste - land disposal, hazardous wastes, abandoned facilities, recovery and recyling energy and materials, and incineration;
- Pesticides and Toxic Chemicals - creation, use, disposal, environmental contamination, health effects;
- Other - noise, radiation, effects of energy development, acid deposition, and biotechnology.

EPA's wide purview evolved over the decade of the 1970s with the passage of nine major environmental laws and their amendments:

- National Environmental Protection Act (1969)
- Clean Air Act (1970, amended 1977)
- Federal Clean Water Act (1972, amended 1977)
- Marine Protection, Research, and Sanctuaries Act (1972)

- Safe Drinking Water Act (1977)
- Resource Conservation and Recovery Act (1977)
- Federal Insecticide, Fungicide, and Rodenticide Act (1977)
- Toxic Substances Control Act (1977)
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (Superfund)

The extensive, sometimes conflicting responsibilities set forth in these laws combined with vocal, contentious, and litigious constituencies severely stressed EPA management in the 1980s. The agency was in a constant struggle to keep up with its court and legislatively mandated workload. Predominant activities EPA engaged in included:

- Developing regulations such as ambient air or water quality standards, discharge standards for municipal or industrial sewage effluents or vehicle emissions, engineering standards for design and operation of hazardous waste facilities;
- Enforcing regulations through monitoring, investigations, assessing penalties, levying fines, and litigation against individual sources or against states.
- Conducting or supporting research on technological controls, health and environmental effects, environmental model development and validation, and monitoring techniques.
- Other activities such as information collection, public education, environmental impact statement reviews, oversight of state activities, exploratory research, and delegation of authority to states.

The agency was organized along media categories in which environmental problems first arose: air, water, solid waste, and pesticides and toxic materials. Serving the media based offices were the laboratories of the Office of Research and Development, the Assistant Administrator for Enforcement and Compliance, Policy Planning and Evaluation, and Admininstration and Resource Management (including information resources). In addition to headquarters staff and the laboratories, EPA had ten regional offices in Boston, New York, Philadelphia, Atlanta, Chicago, Dallas, Kansas City, Denver, San Francisco, and Seattle. The central computer facilites were at the National Computer Center in Research Triangle Park, North Carolina.

EPA did not act alone; it shared responsiblity for environmental management with the states. EPA specified minimum environmental standards for the states and stipulated the ways these standards should be met. In most cases, the states were responsible for implementing federal environmental standards, often with financial assistance from the federal government. The states had little discretion in implementing federal standards other than setting more stringent ones.

Information Collection and Analysis

EPA collected and analyzed a large body of information on the quality of the air and water, worker exposures, food residue, and pesticides, on the production and disposal of waste by companies and municipalities, and on the implementation of regulations and enforcement actions. The agency also carries out research in support of these regulatory responsibilities, including developing monitoring methods, assessment of environmental and health effects, and environmental models. All of these activities depended on information technologies for collecting, storing, analyzing, and presenting information.

In 1985, most of the information (except pesticides and new chemicals) collected on environmental quality came from reports by states and companies to EPA regional offices. These reports were entered into one of the national program data bases where they would be used to create weekly, monthly, quarterly, and annual reports on the status of the environment. These national databases were the central feature in the information landscape of the agency. Much of the agency's efforts were designed to enable EPA Headquarters and regions and State and local officials to improve, maintain, or upgrade these databases. Exhibit 13 lists the information systems considered critical to meeting EPA's mission in 1985. Many of the systems contain data on pollutants and on the quality of the ambient

Exhibit 13

INFORMATION SYSTEMS CRITICAL TO EPA'S MISSION - 1985

WATER SYSTEMS

Storage and Retrieval of Ambient Water Quality Data (STORET)
Federal Reporting Data System (FRDS)
Federal Underground Injection Control Reporting System (FURS)
Needs Survey
Permit Compliance System (PCS)
Biological Data System (BDS)

SOLID WASTE AND EMERGENCY RESPONSE SYSTEMS

Hazardous Waste Data Management System (HWDMS)
Emergency and Remedial Response Information System (ERRIS)
Project Tracking System (PTS)
Office of Hazardous Waste Management/Technical Assistance Data System (OHMTADS)

AIR AND RADIATION SYSTEMS

Storage and Retrieval of Aerometric Data (SAROAD)
National Emission Data System (NEDS)
Air Quality Modeling System (AQMS)
National Air Monitoring Systems (NAMS)
State and Local Air Monitoring System (SLAMS)
Compliance Data System (CDS)
Emissions Certification Data Base (ECDB)

PESTICIDES AND TOXIC SUBSTANCES SYSTEMS

Chemical Information System (CIS)
Pesticide Product Information System (PPIS)
Pesticide Document Management System (PDMS)
Chemicals in Commerce Information System (CICIS)
FIFRA and TSCA Enforcement System (FATES)
Asbestos Information System (AIS)
Technical Data Indexing Systems (TDIS)
Existing Chemical Assessment Tracking System (CECATS)

RESEARCH AND DEVELOPMENT SYSTEMS

Office of Research and Development Information System (ORDIS)
Environmental Assessment Data System (EADS)
Northwest Regional Oxident Model (NERO)
Inhaled Particulates Monitoring (IPMN)
Regional Air Pollution Study (RAPS)
Acid Rain System (SAD)
Quality Assurance Data System (QADS)

ADMINISTRATION AND RESOURCE MANAGEMENT SYSTEMS

Financial Management System (FMS)
EPA Payroll System (EPAYS)
Resources Management Information System (RMIS)
Grants Information and Control System (GICS)
Enforcement and General Counsel Docket System (DOCKET)
Facilities Index System (FINDS)

environment in support of regulatory or enforcement activities. The more prominent environmental quality databases in 1985 included (8):

- Storage and Retrieval of Aerometric Data System (SAROAD) containing ambient air quality data from 6,000 state and local air quality monitoring stations.
- National Emissions Data System (NEDS) containing estimated emissions of SOx, NOx, CO, particulates, and reactive volatile organic compounds. Emissions information was provided by the states who collected it from the 55,000 industrial and municipal facilities regulated by the Clean Air Act. In addition to stationary sources, NEDS also contained data on emissions from small stationary sources, vehicles, and other mobile sources on a county by county basis.
- Storage and Retrieval of Water Quality Data (STORET) which included data on ambient water.
- Federal Reporting Data System (FRDS) which had information on the quality of drinking water, including violations of drinking water standards, for specific public water systems.

Many of the critical systems at EPA in 1985 were designed to support regulatory or enforcement activities. The large systems included:

- Compliance Data System (CDS) which gave the compliance status and enforcement activities relating to specific companies or municipalities emitting air pollution.
- Permit Compliance System (PCS) containing information on the permit status and discharge levels of the 65,000 municipal and industrial facilities in the National Pollutant Discharge Elimination System (NPDES) program.
- Hazardous Waste Data Management System (HWDMS) which had data on generators, transporters, treaters, storers, and disposers of wastes regulated by RCRA. This included data on facilities, waste process design, types of wastes, groundwater monitoring, compliance, and enforcement.
- Comprehensive Environmental Response, Liability, and Compen-

sation Information System (CERCLIS) combined the Emergency and Remedial Response Information System (ERRIS) and the Project Tracking System (PTS) to create a comprehensive automated inventory of the status and projected activities for cleaning up Superfund sites.

- FIFRA and TSCA Enforcement System (FATES) contained information on establishments producing pesticides and data on enforcement activities and compliance rates associated with FIFRA and TSCA. Where EPA had cooperative agreements with the States, projections of inspections and enforcement actions were included.

Incompatibility was a central problem for the more than 260 databases in use in EPA in 1985.(9) Since most of these databases were developed by different offices for different purposes they were difficult to integrate. By 1985, EPA had begun to switch the larger databases to a common software language -- ADABAS. This alleviated the problem somewhat. However, differences in the level and quality of data made integration across media and even within media programs, difficult.

Databases supported agency decisions in the form of reports to management and program assessments. They also were used to generate, support, and validate environmental models. Data on the health and environmental effects of pollutants was not as abundant as many would have liked in the mid 1980s. Many of the laws had been in force less than a decade; hardly enough time to build a well developed body of knowledge. To substitute for long-term data, EPA made extensive use of models. A 1983 directory listed over 150 models ranging from the macro level SEAS model to models of the emissions from the steel industry.(10) Other types of models dealt with stormwater runoff, air quality, acid deposition, urban environments, ocean dumping, noise, risk assessment, agricultural runoff, and soil quality. These models were developed and maintained by the Office of Research and Development as well as program offices.

As part of its responsiblities for controlling pesticides and toxic and hazardous wastes, EPA supported, conducted, and collected extensive information on the qualities of chemicals. Toxicity testing was expensive, $300,000 to $1 million per chemical, and time consuming, often up to a year.(11) For these and political and administrative reasons, EPA had little data on many of the chemicals and substance it regulated. When data was available, it was rarely available across the entire agency — it was usually known by those who had sponsored or conducted the specific research. By 1985 the situation was becoming critical in its complexity. Test data was available at an unprecedented rate — over 1000 studies in two years — while the pressures for regulatory decisions under FIFRA and RCRA increased.(12)

Adding to the the problems of incompatible databases, a proliferation of environmental models, and poor access to toxicity information was the deteriorating state of information technology at EPA. In 1983, the EPA ADP modernization plan stated that resources were near the point of breaking down.(13) The NCC IBM 3080 mainframe and the PDP 11/70 minicomputers used by the regions were bought in the mid 1970s. Between 1976 and 1985 the EPA computing workload had increased fivefold.(14) TSCA, RCRA, and Superfund substantially increased demand as did the EPA staff's growing familiarity with information technology.

The approximately 400 concurrent users of the system were faced with the difficult choice of a) doing without computer support; b) accepting the delays; and c) going to outside contractors. In many cases doing without support was not possible; large databases were involved. Delays meant lower productivity; NIH saved $625,000 in one year when it reduced response time from 8 seconds to 1.5 seconds for its 390 concurrent users.(15) Using contractors was furthering the fragmentation of EPA data systems.

In 1983 an ADP Modernization Program was proposed and approved to provide resources to keep pace with the increased demand. By 1985 implementation of this program was well under way. This included the development of a "logical mainframe" concept involving upgrading the NCC mainframe and phasing out the regional minicomputers.(16) Several of the larger databases were converted or in the process of being converted to ADABAS.

The IBM 3081 mainframe had been upgraded and was providing good service to interactive and batch users. Improvements to the telecommunications network were in place and most remote users of the NCC mainframe had access to high-speed full-screen terminals.

A pilot program to rationally introduce personal computer technology into the Agency had been completed and a long-term procurement mechanism for purchasing personal computers was in place at year-end. Office automation capabilities had been further enhanced by the procurement of 26 PRIME office automation minicomputers.

The PDP 11/70 minicomputers used in the regions were based on obsolete technology and saturated with work, operating at 85 - 95% capacity. The ADP Modernization Program called for the implementation of a "logical mainframe" whereby the regional PDP 11/70 minicomputers would be replaced by mid-sized IBM-compatible devices which would interconnected with each other and with the NCC mainframe with IBM's System Network Architecture. The procurement mechanism for these units was not in place until year-end.

Coordination

Coordination in 1985, as today, mostly involved state and local governments. The federal laws EPA administers give most of the day to day responsibility for managing the environmental programs to the states, as long as states can demonstrate readiness to administer programs and are willing to do so. However, the states were under the strong central guidance of EPA. EPA set the standards and in many cases the approaches and the states carried them out either by collecting information or by enforcing the laws. In the early 1970s the power and direction rested almost solely with EPA. However, with the increase in the competence and professionalism of state agencies came strong pressures from the Administration and the states to give more discretion to the states.

Some argued that the states were not aggressive enough in their pursuit of polluters. Economic development concerns overwhelmed issues of environmental protection in many state capitals. For example, in 1985 more than half the states had laws forbidding the setting of environmental standards more stringent than federal government standards.(17) In enforcement, EPA was not satisfied with the more informal approach of many states in which they preferred to negotiate with violators rather than take formal enforcement actions. These states argued that EPA should pay more attention to compliance and environmental quality data (outputs) than the number of investigations, complaints, or other enforcement actions (inputs). EPA argued that the states tended to concentrate their enforcement efforts on the easy cases. When confronted with recalcitrant violators, the states tended to delay until the EPA was forced to step in an take severe financial or legal actions. In 1985 the relative role of the states in environmental protection remained unsettled.

In the area of environmental reporting, most of the states provided the regional offices printed copy reports which the regions entered into the EPA computer system. A few states sent magnetic tapes or transferred data from their computer systems to EPA computer systems in a batch processing mode, using a program to convert the state data into a form suitable for the EPA computer system. Depending on the particular database, between three and 14 states chose to work directly on the EPA computers.(18) In many cases the lack of access to the results of their input, the complex programs, the problems of the EPA computer systems, and the lack of interactive processing held back greater state use of EPA resources.

Within the federal government, EPA had always been a focus of political attention. It was was tied closely to the Congress. Perhaps as a result, an unusually large number (13) of EPA senior managers were political appointees. EPA reported to 19 House subcommittees and seven Senate panels. EPA reported to Congress over 90 times a year.(19)

With regard to other federal agencies, EPA was the lead agency in reviewing environmental impact statements. By 1985, several agencies complained that EPA was remarkably slow in its processing of EISs. EPA also worked with other federal agencies such as USGS, FDA, and NIH in the maintenance, support, and management of databases.

Perhaps the most notable was the Chemical Information System, developed at NIH, transferred to EPA, used largely by FDA and state and local governments, and finally transferred to the National Science Foundation, which made it available through commercial vendors. On the more positive side many agencies contributed resources and data to STORET, making it a major national asset in the management of water resources.

EPA was the lead agency for U.S. involvement in international environmental activities such as the U.N. Environmental Program (UNEP). EPA was also involved in bilateral environmental monitoring such as the Great Lakes monitoring program with Canada.

Regulation

With the decline in resources for EPA's regulatory enforcement in the early 1980s, the level of voluntary compliance dropped. A GAO report reported that 71% of companies were in substantial non-compliance with federal water and hazardous waste regulations.(20) Even when EPA sought to prosecute violators, 80% of its actions were challenged in court.(21) EPA, using a different definition of compliance, noted that the GAO report was faulty and inaccurate. In any case, by 1985 the situation had improved. EPA Administrator Ruckelshaus made enforcement a priority in his brief second coming to EPA. The enforcement and compliance databases were improved and upgraded. The National Enforcement Investigations Center in Denver provided technical expertise, information, and training in support of enforcement.

Two information related developments began to change the quality of enforcement in 1985. First, more standards and regulations were going to negotiated rule making. In such rule making, the key affected parties work together to create a rule or regulation they can observe. By selecting rules with a limited number of affected parties, full technical and health effects data, finite number of issues, and low emotional content, these negotiations were able to create rules which were less likely to be challenged and more likely to work. The second development was the Environmental Photographic Interpretation Center. Using advanced equipment capable of high resolution infrared, heat sensing, and conventional photography, EPA used U-2s and Cessnas to make aerial surveys of possible dump sites -- current and abandoned. Technology allowed EPA to identify abandoned dumps, count the number of barrels at dump sites and track pollutants.

Information Dissemination

Dissemination of printed information on the environment was at a low point in 1985. In the late 1970s EPA provided extensive printed information to the public. With the change in Administrations came a virtual embargo on publication of EPA reports. Despite the cutback, those groups who were active in environmental policy -- from the Chemical Manufacturers Association to the Sierra Club -- were able to keep abreast of new environmental information. It was the wider public that had less access to information. A notable exception was the 1984 report Environmental Progress and Challenges: An EPA Perspective, which presented integrated data from the ten regions on the current and future state of the environment.

On the positive side, there was renewed interest in public involvement in environmental decisionmaking. In Tacoma, Washington EPA proposed strict regulations on the arsenic emissions from the ASARCO smelter. Using public input, EPA refined its models and its estimates of emissions and changed its strategy from regulating one set of smokestacks to regulating several sources of emissions.(22) This involvement program was a first step in what Administrator Ruckelshaus saw as a significant increase in public information and public education. The thrust of such a program would be educating the public on the need to a) accept some degree of uncertainty in environmental matters, b) accept some level of risk, and c) develop reasonable expectations about what could be done to protect the environment.

Personnel(23)

The early 1980s saw a sharp reduction in the EPA workforce as part of the Reagan Admininstration's deficit reduction program. In 1980, there were 11,200 permanent full time workers at EPA and an additional 3,000 part time, temporary, or contract workers. By 1982 the number of full time workers had dropped to 10,000 and the number of part time and other workers to approximately 1,500. In 1984, EPA was down to 8,100 full time employees. This reduction in force hampered EPA's ability to meet its legislative and court mandates. To rebalance the situation Administrator Ruckelshaus hired a substantial number of people to assist with the Superfund program.

With the decrease in EPA's staff, the agency relied even more heavily on contractors for data base development and maintenance. The agency also transferred more responsibility to the states who had over 20,000 employees involved in environmental protection.(24)

Support Services/Procurement/Grants

EPA was housed in more than 40 buildings around the country in 1985. Some of these were laboratories and others were regional federal buildings. EPA headquarters was in the Waterside Mall in Washington, D.C. There were severe crowding and support service problems at the Mall; for example, when EPA attempted to convert part of the Mall's garage space to offices they were forced to defer the project when unacceptably high levels of carbon monoxide were detected.

The agency relied on 1200 to 1400 stand alone Lexitron word processors for most office work.(25) The ADP modernization program called for offices to shift from the word processors to PRIME 2250 office computers. There were 26 such computers in use in EPA by 1985. There were also 300 to 400 IBM microcomputers in use — many by non-scientific end users. Problems with wiring computers and other information technologies were common, especially at the Mall.

Procurement was supported by several information systems (see Exhibit 13). Most notable were the Grants Information and Control System (GICS) and the Automated Procurement Documentation System. EPA transferred funds to states, local communities and other agencies through Section 208 construction grants, general grants, interagency agreements, research grants, and specific projects. The GICS data base was used to monitor and project these transfers. EPA also did a large amount of contracting. To support the contracting effort the agency developed a computer based expert system for the preparation of Requests for Proposals. This Automated Procurement Documentation System saved many hours in the preparation of RFPs.

Planning

Planning at EPA involved the development and presentation of printed reports. The production of these reports was enhanced by the expanding computing and graphics capabilities of the new information technologies and by the improvements in EPA databases. However, there was no agency wide integrated Management Information System; most of the planning was carried on in the media offices. The continually changing location and focus of long range research at EPA indicated the lack of a commitment in the Agency in the early 1980s to integrated long-range planning.

INFORMATION TECHNOLOGY AT THE ENVIRONMENTAL PROTECTION AGENCY - 1991

This section discusses the changes in the use of information technology at the Environmental Protection Agency since 1985. At the beginning of this report, the key developments were highlighted. This section expands on those highlights. The discussion follows the same format as the 1985 discussion -- beginning with the mission moving to key information technology functions of information collection and analysis, coordination, regulation, and information dissemination. It finishes with other functions — personnel, support services and procurement, and planning. These changes and the forces driving them are summarized in Exhibit 15.

Mission

The mission of the Environmental Protection Agency remains the same as it was in 1985 -- coordinating the federal government's activities designed to protect the environment. Public support for protecting the environment continues to be strong. EPA remains the primary public advocate for a liveable environment.

While the overall mission of the agency has not changed, the primary problems it deals with are different than they were in 1985. Groundwater contamination has become a first magnitude problem of national significance, one which is taking up more of EPA's resources since the 1989 Surgeon General's report on the Quality of Drinking Water declared over half the aquifers in the U.S. hazardous to Americans' health.(26) Other continuing and new problems of importance to EPA are the growing use of biotechnology; the widespread use of specialty chemicals and composite materials; aging nuclear power facilities, and indoor air pollution.(27)

In addition to these new problems, EPA's attention has shifted to the health effects of pollution. Where most health effects research went to cancer and birth defects in 1985, now EPA must address a wide range of potential health risks. The major new areas include brain function, effects on the immune system, and aging.(28)

With the growing concern over the health effects of pollution has come a greater demand for specific indicators of environmental protection. EPA programs are concentrating on measuring the level of environmental protection and the documented results of EPA efforts to clean up hazardous and toxic wastes, polluted water bodies, and harmful indoor environments.

The focus on results is reflected in a trend toward greater flexibility in EPA's relations with states and industries. Beginning with the "bubble" policy allowing emissions tradeoffs and continuing through the present insurance based program for protecting indoor environments (see Coordination section below), EPA has allowed companies and states to design approaches to achieving the goals Congress and EPA set. The key to success in this approach has been the incorporation of explicit indicators of environmental protection.

While EPA continues to be organized in terms of air, water, toxics and pesticides, and solid wastes, cross media integration is more prevalent than it was in 1985. Much of this increase is attributable to the better, more uniform, and accessible databases on air, water, and wastes. Also, with the growing attention to groundwater problems, EPA has become more sensitive to the interrelationships among different pollutants. For example, acid rain, agricultural pesticide use, toxic waste dumps, and stormwater runoff all contribute to the contamination of groundwater. To protect and clean up valuable aquifers, EPA has had to take a multimedia approach.

The most significant organizational change in EPA has been a shift to a more regionally based agency. EPA headquarters is largely a policy unit; most of the regulatory oversight, data collection, analysis, and reporting is done on a regional basis. National level reports are extracted from the regional reports. Several forces created this shift to the regions. First, as data and analysis of environmental problems accumulated, the importance of local and regional geographic, economic, and political factors to successful environmental protection became apparent. Second, the shift to results, coupled with more discretion and responsibility at the state level made the regional offices a more suitable base for environmental protection. Third, the successful adoption of the "logical mainframe" concept for EPA data processing enabled EPA regions to do the equivalent level of data collection, analysis, and modeling once reserved for the national level offices.

Information Collection and Analysis

The ADP modernization program begun in 1983 has been completed leaving EPA with a modern, efficient, and integrated information system. Significant changes have occurred in databases, modeling, research on health effects, and information technology hardware.

Databases have become more integrated and more standard at EPA. The number of databases has fallen from 260 to 74.(29) All major databases use ADABAS — EPA's standard database management language. Three databases account for the bulk of information collection and analyses:

- Aerometric Information and Retreival System (AIRS) combines SAROAD, Compliance Data System, and National Emissions Data System to create an integrated, easily accessible, high quality information system showing air quality status and trends (Air Quality Subsystem) and the sources of air pollution throughout the country (Facility Subsystem).
- Storage and Retrieval of Water Quality Data (STORET) has become the primary water quality database. By tying the COGENT files (projections of the demand for and effects of wastewater treatment facilities) and the Needs survey of the costs and technical requirements of current and projected wastewater treatment facilties to STORET, EPA now has an integrated picture of the current and future effects of municipal and industrial wastewater treatment. Since STORET is structured so it can receive data on pollutants in other media, it has been of substantial value in supporting EPA's groundwater related activities.
- The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) has become the central waste disposal database for the agency. It is the repository for all monitoring, compliance, and enforcement information

dealing with RCRA and CERCLA. This includes the former FATES, Hazardous Waste Data Management System, and the Existing Chemical Assessment Tracking System.

These systems are developed and maintained centrally by Headquarters staff, but data in the systems is entered and maintained by the regional and state personnel. Three factors promoted this decentralized approach. First, the "logical mainframe" concept means that each of the regions operates in an identical software environment. Second, EPA has designed an expert system for use by the regional offices in checking the quality of the data reported by the states obviating the need for a national level quality assurance program. The wide ranging effects of the use of computer based expert systems have been most beneficial throughout all of EPA and will become more so in the next four years. The profound impacts of expert systems was effectively scoped out in an old 1985 memo which recently came to our attention (Exhibit 14). The Data Quality Assurance System uses multiple crosschecks to identify anomalous entries worth a closer look by state or EPA inspectors.(30) Third, the cost of monitoring has declined while accuracy has significantly improved with the growing use of automated sensors. These miniature sensors have sufficient power to transfer data to nearby microwave receivers which transmit the data to state or regional collection stations. As a result of the introduction of these monitors the quality of data on ambient environmental quality has improved.

Modeling remains an important activity at EPA. The large amount of data and better quality data have been reflected in better, more accurate environmental models. The specific changes in modeling include:

- More access to models as a result of the widespread use of personal computers at EPA.
- Easier access to models because of the shift to standard software languages in EPA.
- More valuable models as a result of widespread use of regional and locally specific data and assumptions in models.

Exhibit 14

Memorandum 6/3/85

Subject: The Future Consequences of Expert Systems on EPA's Activities

From: John Nemo

To: The Administrator

In response to your recent request I offer the following observations on rapid developments now taking place in the computer industry in the field of artificial intelligence[1] and on how these technological developmnts may impact EPA's mission.

For instance, recent literature on the subject of artificial intelligence[2] suggests at least half a dozen generic categories of so-called knowledge engineering applications. Many of these applications require super-minicomputers at a minimum, primarily because of requirements for memory and speed of processing time. Others will require supercomputers capable of upwards of 500 MIPS.

However, the arrival on the market of microcomputers with the Intel 80286 chip will allow individual users to develop stand alone models and expert systems which will utilize the ability of new operating systems (Microsoft DOS 4.0 and 5.0) to address up to 4 Mb of RAM and as much as 16Mb of virtual memory. EPA is planning to purchase as many as 8,000 of these machines over the next 5-7 years. While these machines will not replicate the functions of supercomputers, they will provide enhanced computing power in the area of decision support systems, which is an allied management function of expert systems.

A brief review of these expert system applications and their potential impact on EPA follows. Some will be feasible on the types of micros noted above. Others will certainly need much more processing power.

The category of "interpretation" involves inferring situation descriptions from sensor data. This application is obvious in terms of EPA's current approach to pollution monitoring. It has implications for EPA enforcement functions, especially where there are multiple dischargers of residuals into the water, the air, and on land. The use of "inference engines" to combine hard data from many discharge monitoring reports will allow EPA to determine not only noncompliance, but also to assess penalties related to subsequent harm associated with the transport and fate of toxic or hazardous residentuals. This capability will be supported by the category of "prediction."

The category of "prediction" involves inferring likely consequences of given situations. The possibilities here are more robust given the emergence of high speed, parallel processing supercomputers. These machines and their software may be able to more adequately address the types of problems encountered in large-scale ecological models, including those attemtped several years ago in the Global 2000 Report. The EPA effort to clean up the Chesapeake Bay and other estuaries is also a possible arena for this technology.

EPA may find its mission changed because of the ability of information processing technology to analyze and make sense of dynamic changes in large scale ecosystems. EPA's mission may change from a maker of decision rules for discharge of pollutants to a manager of ecosystems. This change may have massive impacts in the western U.S. where several other federal agencies have struggled unsuccessfully for decades to achieve this objective.

The category of "diagnosis" may be useful as an application in determining the health effects of new chemicals by modeling their impacts rather than waiting for 20 years of statistics on cancer rates, birth defects, and other types of human suffering.

The category of "design" may be useful with regard to CAD/CAM in developing new, more efficient, and less costly pollution control machinery such as wastewater treatment plants, air pollution scrubbers, etc.

The category of "planning" may be helpful, again through modeling, in mapping out management strategies for new regulatory agendas, assessing the impacts of new regulations on the economy, and in identifying other societal costs and benefits.

The category of "monitoring" may be useful in accumulating large amounts of ambient and point source data on residuals discharge, transport, and fate at a regional, national, or perhaps even multinational scale. The current problems associated with determining a viable acid rain control program may be addressed by this technology.

Many other knowledge engineering functions relate to the development, maintenance, and improvement of computers in and of themselves and do not lend any new insights to EPA's mission. In short, artificial intelligence will impact EPA's mission.

If you have any questions, please call me on 966-9307.

Footnotes

[1] Feigenbaum and McCorduck, "The Fifth Generation," Addison Wesley, 1983

[2] Hayes-Roth, et al., "Building Expert Systems," Addison Wesley, 1983

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*This memo is based on a 1985 working paper by Dan Yurman of EPA.

- More accurate models as a result of an agency wide Model Validation Program begun in July of 1989.(31)

Health effects research advances have enhanced the validity and use of EPA models. Improved toxicity testing methods and the growing use of surrogate indicators have decreased the costs of health effects research while narrowing the confidence limits around results.

With the emphasis on health effects of pollution EPA has pioneered the development of automated environmental health records and portable environmental monitors. Using the technology of "smart cards," EPA began a trial program of environmental monitoring with 750 volunteers in 1988. Since then more than 5,000 volunteers have had a personal environmental history interview, an assessment of the environmental quality of a person's home, workplace, and automobile, and thorough biological, chemical, and physical testing. The results of these tests and assessments were recorded on smart cards known as ECOCARDs.(32) The ECOCARDs are also equipped with miniature environmental sensors. Volunteers are asked to carry the cards on a chain around their necks at all times. Each wave of volunteers will have their monitors scanned and receive follow up testing every two years; the starting wave of 750 volunteers has just completed its first follow up.

As part of its 1990 labor agreement, the Chemical Workers Union (CWU) demanded that all its members be outfitted with ECOCARDs. The data from the ECOCARDs will be available to EPA, the union, the industry, and the public. CWU officials are certain that the results of the monitoring will verify their claims of unhealthy work practices.

Information technology hardware has improved since 1985 primarily through the introduction of the "logical mainframe" concept. This concept involved substituting a more powerful mainframe computer (IBM 3090 Sierra series)(33) and mid-sized IBM-compatible regional machines, IBM-compatible telecommunications and personal computing equipment for the previous smaller mainframe and collection of regional minicomputers. Also, all administrative and office related computing (except for large administrative systems such as payroll) was shifted off of the mainframes and minicomputers to 75 PRIME 2550 office computers and to personal computers located throughout the agency. As a result there is a computer or terminal for every employee in EPA.

The logical mainframe concept has worked because the computing and telecommunications capacities (using the IBM System Network Archictecture) have been sufficient to keep waiting time to under two seconds despite growth to over 575 concurrent users.(34) Also the concept requires identical software environments throughout EPA and thus has given valuable impetus to the standardization and integration of EPA databases and models.

Coordination

The states are responsible for day to day management of the environment. They collect the bulk of information on environmental quality and on polluters. They also do most of the enforcement of federal environmental regulations. EPA provides the states with technical assistance, money, and support. EPA also sets specific, numerical goals for the states. These goals deal with improvements in environmental quality resulting from state environmental protection activities. The specific means for meeting these goals are up to the states. EPA grant and assistance decisions are tied to states' performance.

When interstate or national problems arise, EPA takes the lead. For example a national firm with a record of non-compliance in several states is likely to deal with EPA rather than the individual states. Acid rain, interstate migration of pollutants in aquifers, and controlling the environmental effects of nuclear facilities and wastes are national level issues and therefore the responsibility of EPA; it designs the strategies which the states carry out.

Information technologies have enabled EPA and the states to develop this division of responsibilities. The logical mainframe concept has opened up EPA to greater state participation. Now, depending on the database, between 34 and 46 states report directly to EPA computers.(35) Increased direct reporting means greater state access to EPA databases; in 1985 several key databases such as FATES were not available to the states. With more access the states have a greater interest in making sure the data they provide to these databases is the best possible; sixteen states use EPA's Data Quality Assurance System to check their environmental reports before reporting to EPA.

While EPA still seems to spend every third day on Capitol Hill, the tenor of the relationship is less contentious. Since the committees have direct electronic access to EPA databases, conflict over points of information have been displaced by fuller attention to points of policy.

The Council on Environmental Quality Blue Ribbon Panel on EIS reviews was set up in 1987 to develop an automated review process for all federal EISs.(36) The result of their two year labor was an expert system for reviewing the information in EISs including completeness, accuracy, and significance of the statement. EPA now uses the Expert Review System (ERS) to process all federal EISs; as a result the backlog of EIS to review has disappeared. Several agencies, most notably the Department of the Interior, have adopted their own versions of ERS to assist in the preparation of their EISs.

As part of its increasing interest in the health effects of pollution, EPA has set up an Interagency Data Exchange on Health Effects Research.(37) The Exchange has significantly enhanced EPA's access to research on toxicity, immunology, brain chemistry, and aging effects of pollutants. The other major participants in the Exchange are OSHA, NIH, National Library of Medicine, FDA, and CPSC.

EPA relations with industry have also changed as a result of indoor pollution concerns.(38) By 1987 the number of court cases involving the health effects of pollution in offices was growing rapidly. After $100 million was awarded to the employees of Office Work, Inc. the insurance industry got involved. After consulting with EPA and OSHA, a consortium of the Equitable, Hartford, and Aetna insurance companies began offering office health insurance.

The insurance involves an initial EPA/OSHA certified assessment of the quality of the office environment followed by annual testing of the environment and the employees. In exchange for certification of testing, EPA and OSHA get all assessment and testing data.

Regulation

The efforts of the past four Administrators, continued support in the courts and in Congress, and improved detection and tracking methods have resulted in 70% of all regulated facilities being in voluntary compliance with EPA air, water, and waste regulations.(39) This contrasts with the 71% non-compliance cited by GAO in 1984. The number of court challenges to EPA actions has declined from 80% of all EPA actions in 1984 to 37% in 1990.(40) All of this occurred while EPA and the states were imposing stricter limits on polluters as more became known about the extent and effects of industrial, municipal, and residential pollution.

Information technology developments such as waste handlers tracking, Environmental Photographic Interpretation Center (EPIC) improvements, and negotiated rule making have fueled the increase in compliance. As part of CERCLIS, EPA has developed a Criminal Waste Handlers Tracking System which matches all stockholders, directors, and principals in waste handling firms with FBI files on organized crime figures.(41) Several Mafia based waste handling firms have been identified, investigated, and the principals brought to trial using this tracking system.

The Environmental Photographic Interpretation Center (EPIC) has become an important source of enforcement information. The release by the Defense Department of formerly classified reconnaissance satellite images of the U.S. from 1965 to 1980 have provided a baseline for identifying changes in waste facilities. EPIC has a computer based photographic comparison/scanning system to identify possible environmental changes. The development of this artifical intelligence system was done with the assistance of the Department of Defense.(42)

Negotiated rule making is used with 23% of all EPA rules.(43)

The process has been improved through the use of more and better data and the adoption of automated group management tools. The Consensor gives groups anonymous instant feedback on differences, making it easier for facilitators to manage conflict. Computer based policy capturing or judgment modeling provides groups with an early picture of the key variables driving the different points of view in the group. This has also improved the ability of facilitators to develop consensus on a rule.

Information Dissemination(44)

Information technologies have improved the ability of EPA to inform and educate the public. EPA documents are more readily accessible than in the mid 1980s. There is a public database maintained by EPA giving abstracts of all EPA reports. The full reports are available on line and in print at local libraries on an as needed basis. The cost of printed copies of most EPA reports is relatively much higher than on line, at an average of $93.

EPA also provides the regulated community with current information through its electronic regulation bulletin board. For a nominal fee companies and individuals can get access to the EPA bulletin board which gives daily updates on the status of rules, regulations, and other agency activities. The bulletin board notices are backed up by a teleservice center comprised of 800 numbers and taped messages providing more information on specific rules or activities.

In the area of public education, EPA has opened its models to the public. There is an EPA environmental model clearinghouse which offers people guidance and information on using environmental models. Recently the agency instituted a public access period from 9PM to 3AM Mondays and Fridays in which people can have access to the EPA mainframe to run EPA environmental models. To gain access, individuals must take three hours of computer based instruction on the use of environmental models. Several commercial software packages suitable for home computers have been developed to meet the growing public interest in environmental models.

Models have also become important adjuncts to public involvement.

When seeking public comments on a proposed change such as a new air quality standard, the agency will illustrate the effects of the new standard with a model simulation. When people question the model's assumptions or results, an EPA official will rerun the simulation with altered assumptions or data. The public response to the use of these models has been uniformly favorable. The models have been improved through greater attention to specific regional or local factors and to results of interest to the public.

Personnel

The number of full time employees at EPA has leveled off for a 1985 base of 9,100 with more than half of these in regional offices and agency laboratories.(45) There are fewer clerical workers at EPA and more analysts. The number of managers and senior level executives has remained the same.

EPA has been able to attract and keep qualified information professionals. The modern IBM system coupled with relatively secure government employment and challenging work make EPA attractive to many data processing professionals. However, EPA has had a problem in attracting people trained in developing and maintaining expert systems. The demand for people competent in artificial intelligence in government and private industry outstrips the supply. Most of the expert systems work at EPA is done by Excon employees, who work under the extended contract program designed to assure work for a minimum of three years.(46)

Support Services/Procurement

EPA has fewer buildings than it did in 1985. Several of the laboratories have been sold to the private sector or given to nonprofit institutions. In two cases, the employees of the laboratories bought the labs from the government using Employee Stock Option Plans.(47) Part of the condition of the sale was continued access, at reduced rates, to the EPA National Computer Center. EPA's presence in regional federal facilities has increased. With it has come greater demands on GSA for facilities capable of handling the power and telecommunications needs of the regional offices. In two regions, EPA offices are still operating under makeshift conditions.

Administrative systems have been combined into an overall project and resource tracking system. Most of the money flowing out of EPA goes to the states and localities. However, EPA continues to make extensive use of contractors for everything from databases to toxicity testing.

Planning

The presentation of data for management decisions has become more useful and more standard with the growing use of commercial graphics software. Integration of EPA databases has fostered an agency wide integration in which planning has played a growing role. The integration of administrative databases has provided planners with an integrated Management Information System for the entire agency.

INFORMATION TECHNOLOGY AT EPA: A LOOK TO 1995

While the Environmental Protection Agency has made big strides since 1985, changes and improvements are still needed. This section describes information technology related changes proposed for the next four years, from 1991 to 1995. As with the previous two sections, the discussion begins with the mission, moves to key information technology related functions — information collection and analysis, coordination, regulation and information dissemination -- then finishes with a discussion of other functions — coordination, planning, personnel, and support services. The changes are summarized in Exhibit 15.

Mission

In the next four years, the mission of EPA will remain the same. The problems EPA will face are already visible — groundwater contamination, nuclear facilities, acid rain, and non-ionizing radiation. The common theme in all these problems is that their effects cut across the traditional media distinctions within EPA. This agenda of problems and the growing integration of EPA databases suggests even further movement toward an integrated cross media approach to environmental protection. This will probably show up in the passage of the long awaited EPA Organic Act.

In addition to codifying the ecological focus of the agency, the organic act will reduce the overlap and inconsistencies in the many environmental laws EPA administers. Whether or not the organic act is passed, EPA will be reorganized into Research, Monitoring and Information Collection, Standards Setting, Enforcement and Compliance, and Administrative divisions in the next four years.

Information Collection and Analysis

As part of EPA's move to greater integration, we can expect a higher level of aggregation and integration in EPA databases. Now, AIRS, STORET, and CERCLIS are distinct databases serving different media offices. As EPA is reorganized, it will be necessary to combine these databases into a National Ecological Monitoring and Information System (NEMIS). The integration of the databases will not be difficult since they all use ADABAS.

NEMIS will be of the most use to state and local organizations if it is able to tie to specific small areas. EPA intends to include the Census Bureau's Topographically Integrated Geographical Encoding Reference (TIGER) in NEMIS. TIGER is a precise locator file which uses data from the Global Positioning System (GPS) of the Navstar satellite network.(48)

By using TIGER, EPA can more precisely record the data coming from its remote monitoring network. By 1995, the network will be maintainted by robots. These all-terrain robots will use the GPS to locate and place monitors. The robots will also be capabale of reading, repairing, and reprogramming sensors. A pilot project using robot maintenance systems will begin this summer in Yellowstone National Park.(49)

To meet the growing demands for access to EPA information and the expanding EPA responsibilities, the National Computer Center anticipates adding another IBM Sierra series mainframe within the next four years.(50) Without such additional capacity, the decentralization and cross media approach which characterizes the EPA of the 1990s may falter.

In addition to adding to its own computing capacity, EPA will be supporting research on the National Weather Service's supercomputers. EPA will need climatic modeling to help identify the possible effects of the shift away from landfill disposal to ocean based incineration of toxic and other wastes.

Coordination

Relations with the states are likely to stabilize over the next four years. By 1995, all states will be reporting directly to EPA computers.(51) All editing and checking will be assisted by expert systems. States and local governments will have access to all EPA environmental quality and enforcement data.

Corporations are becoming more aware of the importance of environmental information to their decisionmaking. This interest is manifesting itself in a growing market for commercial environmental modeling services. At present there is no quality control on these services. Within the next four years, EPA may be asked to certify the models and services offered by these companies, especially if they use derivatives of EPA models.

Regulation

Improved data, better knowledge of health effects, continued public support for environmental protection, and better enforcement systems will mean more voluntary compliance with environmental regulations in the future. EPA anticipates an 86% voluntary compliance rate by 1995.(52) In support of that goal, EPA will continue to strengthen its Criminal Waste Handlers Tracking System and to strengthen the National Enforcement Information Center. EPA will also look for data such as Commerce trade data, Census economic census data, OSHA and FDA reporting data which can be used to match with EPA files to identify possible polluters. By 1995, EPA will have its own reconnaissance satellite with the broad and close look capabilities of the military reconnaissance satellites of the early 1980s. This changes mean only 14% of EPA decisions will be challenged in court in 1995.(53)

Information Dissemination

In the next four years, EPA will further expand its ability to provide the public with environmental information. The teleservice center supporting environmental regulations will have a subsystem composed of automated expert systems for assisting companies in filling out and filing environmental reports. The teleservice concept will be expanded to regional teleservice centers open to the public offering brief synopses of current environmental quality and protection activities and information referrals.

In addition to general environmental information, EPA will open up the ECOCARD system to all those who wish to participate. State and local environmental agencies will do the assessments and testing with technical and financial support from EPA. Also by 1995 the dosimeters currently on smart cards will be available as skin implants. This will make the information more accurate and easier to collect. In addition to volunteers, OSHA anticipates union demands leading to widescale use of ECOCARDs in the more hazardous industries.

Personnel

EPA staff will not grow between now and 1995 but it will change. The trend toward fewer clerical workers and more analysts will continue as more people become adept at using the new information technologies. There will be continued competition for people with expert systems skills, leading to continued use of contract workers in that area. At the same time, the EPA staff will become one of the oldest in government as many of the young people who joined the agency in the 1970s work through to their retirement.

Support Services/Procurement

The next four years will see consolidation of the changes made in the last six years. EPA headquarters will move to a new more modern location capable of handling the expanding needs of EPA information technologies. The two regional offices currently working under makeshift conditions will move to more suitable quarters. The volume of paper stored will drop dramatically as much of EPA files and data will be stored on laser disks. As many as three more labs may be taken over by employees in the next four years.

Planning

Planning will be better with an organic act, the integration of databases, and improved coordination with the states. The next four years will see increased reliance on cost/benefit analyses as the results of health effects research and data base integration enable greater specifity in the documenting of costs and benefits.

SECURITY, PRIVACY, AND PUBLIC INFORMATION IMPLICATIONS

The information technology changes since 1985 and the changes proposed for 1995 will improve the ability of EPA to ensure a liveable environment for all Americans. In addition to improving accuracy, timeliness, and efficiency of EPA operations, these technological changes alter the way EPA relates to the public, to business, to public interest groups, and to other levels of government. Specifically, they affect the security of EPA operations, privacy, and the provision of public information. Most of these changes have already been noted; they are summarized here.

Security

Security has not been a central concern at EPA. In 1985, ADP managers were confident that all reasonable precautions against unauthorized access and falsifying data had been taken. The confidence of the mid 1980s was jolted in 1988 when American Pesticide sued EPA for failing to protect the integrity of its environmental reports.(54) American Pesticide entered an application for pesticide review in early 1986. Sometime after that someone, most likely with ties to one of American Pesticide's competitors, gained access to the application and changed some critical test data. When EPA demanded additional testing, American Pesticide refused, saying the data did not warrant such testing. Once EPA and American Pesiticide compared notes it was clear what had happened and the pesticide registration was granted. The thrust of the suit is that EPA's failure to protect Pesticide's data harmed the company's competitive advantage by unecessarily delaying market introduction of the pesticide.

In a another case an EPA employee was convicted of insider trading based on unauthorized access to proprietary and encrypted corporate information in EPA's secure database. By reviewing applications for new chemicals from 1987 to 1989, this employee was able to make investments in chemical stocks that netted her over $500,000. Her activities were discovered during the introduction of electronic audit trails in the CERCLIS data base. She faces a $20,000 fine and ten years in jail.(55)

The security concerns have not all come out of EPA headquarters. Several Chemical Workers Union locals are accusing their employers of illegal practices regarding their ECOCARDs. One local claims that the employer is using low level electromagnetic radiation to jam the sensors on the smart card. Another local claims that when the company reads the data every six months it is altering the data to avoid any possible lawsuits. EPA is currently looking into improving ECOCARDs so they will not be vulnerable to such tampering.

Remote monitors have also been sources of security concerns. Several states using the EPA Data Quality Assurance Program have identified questionable readouts from remote stream water quality monitors. After replacing the monitors, they noted other monitors giving anomalous readings. An investigation revealed that a company upstream from the monitors had altered them to avoid detection of unauthorized discharges of heavy metals which could be traced easily to that company.

Privacy

Added to the concerns over the integrity of data within the EPA system are problems with confidentiality of data provided to EPA. EPA depends on voluntary compliance with reporting and pollution control regulations. Most of its efforts have been focused on improving the deterrents to non-compliance — stepping up enforcement, tracking criminal waste handlers, and levying more fines and penalties. In the drive to increase enforcement, the agency has run into problems in assuring personal and corporate privacy.

The Criminal Waste Handling Tracking system was challenged in ACLU vs EPA (1987).(56) The court held that given the imminent risks to human health from illegal disposal of toxic and other hazardous wastes, the federal government had the right to use FBI files to locate known criminals operating waste handling companies. However, the court cautioned EPA against casting the net too wide in its search for criminal connections to waste handlers. The definition of the scope of EPAs investigatory purview is still being determined. Also the Court restricted the federal use of the system to interstate violations of dumping regulations only; all other violations are the responsibilities of the individual states.

There have been similar concerns with EPA's attempts to identify polluters by computer matching and remote sensing. By putting together information from many different federal databases to challenge company environmental reports, several companies have argued that EPA is unlawfully harrassing them. Two cases are currently before othe U.S. District Court on this issue. A Florida company is charging that EPA unlawfully searched and seized evidence when it used EPIC photographs to prosecute the company. This case is also before the U.S. District Court.

Another source of concern is the growth in the number of people with access to sensitive corporate data. The Chemical Manufacturers Association has called on EPA to institute much stricter controls on access to this data. The targets of these controls are the many state and local officials who now have access to EPA enforcement databases. In a similar situation, EPA assured all ECOCARD volunteers that the data they provide will be held in the strictest confidence. Recent revelations of security breaches in EPA data bases have led 134 of these volunteers to drop out and to demand that all records of their participation be destroyed.

Public Information

In the mid 1980s EPA's public reputation for effectiveness was at best mixed if not poor. The Administrator realized that only extensive public outreach, involvement, and education programs would restore public belief in EPA as a fair arbiter of environmental issues. As a result, the information available to the public about the environment is more extensive, more detailed, more valuable, and more available than ever before. The planned enhancements to the EPA databases including the additon of the TIGER file will make these files even more valuable to the public. Teleservice centers, public access to environmental models, and the use of model simulations in public involvement activities have also contributed to the growth in public access to information.

Despite these improvements, unresolved issues remain. Several environmental groups charge that the data EPA provides to the public is sanitized; it does not show the significant environmental harm that many compaines are still inflicting in many areas. They also charge that the EPA simulation models bear little resemblance to those models and decision tools EPA decisionmakers use; the public involvement models are the information equivalent of "bread and circuses." Others argue that EPA has gone too far in catering to the computer literate portion of society. The high cost of reports makes it difficult for people without access to and familiarity with computers to participate as effectively relative to others in environmental policy debates. They argue that depository copies at local libraries are not sufficient.

CONCLUSION

With the introduction of the logical mainframe concept, EPA has been able to effectively move to a decentralized, regional approach to environmental protection where the states handle the day to day management of the environment, EPA regions provide oversight for state activities, and EPA headquarters gives policy guidance. Improved information databases, modeling, and health effects monitoring have helped EPA take a more integrated approach to environmental protection. More and more we are reducing environmental risk, not just transferring it from air to water to land to the oceans.

Exhibit 15

INFORMATION TECHNOLOGY AT EPA

1985, 1991, 1995

CATEGORY	1985	1991	1995	KEY FORCES
MISSION	Coordinating effective governmental action on behalf of the environment; 9 major environmental laws; organized by media; shared responsibility with states.	Same mission; focus more on groundwater, biotechnology, new materials; health focus including aging and immune systems; results oriented and more flexible;regional organization.	Same mission; regional focus strengthened; groundwater a continuing priority; cross media, ecological approach; possible EPA organic act to rationalize responsibilities.	Strong public support for environmental protection; shift to more state responsibility; improved knowledge of ecological principles; continued concern with health and fitness.
KEY FUNCTIONS				
Info. Collection and Analysis	250 databases - some in ADABASE; many are incompatible; 150 models; outdated mainframe and obsolete minis at regional offices; 300-400 micros in use.	Integration of databases - AIRS, STORET, & CERCLIS. ECOCARDs used to monitor health risks; IBM Sierra mainframe and more PRIMES. All employees have terminals.	Integration of AIRS, STORET, and CERCLIS into NEXIS; inclusion of Census TIGER file; robot maintenance of monitors; additional IBM Sierra mainframe.	Conversion to a standard database language to improve integration; need to simplify reporting process for states; improved modeling capabilities.
Coordination	Mostly with the states; most states provide printed data input; 6-14 use direct access to EPA computers; slow in reviewing EISs.	Close relations with states; states determine approaches; 34-46 states report directly to EPA computers; expert system for EIS review.	More state responsibilities; all states report directly to EPA computers; EPA certification of commercial enviromental models.	Increased state competence; continued use of EPA as a national level policy maker/enforcer; pressure to deregulate.
Regulation	71% in non-compliance with water and waste regulations; 80% actions challenged in court; move to negotiated rule making and EPIC use.	78% compliance with air, water, waste regulations; 37% actions challenged; criminal waste handlers tracked; EPIC improved.	86% compliance with regulations; 14% of actions challenged; matching with other federal data sources to find polluters.	Public concern over health effects of pollution; better remote sensing/data matching techniques; strong Congressional support.
Information Dissemination	Few printed reports available; renewed interest in public involvement - ASARCO smelter case; more public education.	Public database; reports available on line and in print at local libraries; regulation bulletin board; public access to EPA models; models used in public involvement programs.	Public teleservice center and automated expert systems to assist preparation of environmental reports; open up ECOCARD program to all.	Increased public awareness of environmental issues; improved public information handling capabilities; need to reestablish public confidence in EPA.
OTHER FUNCTIONS				
Personnel	1980 - 11,200 full time; 1984 - 8,100 full time; heavy reliance on contractors and states.	9,100 full time employees; more analysts, fewer clerical workers; hire expert systems researchers on contract.	No change in number of employees; more analysts and fewer clerical; aging of EPA workforce accelerates.	Pressure to reduce federal deficit; growing need for top level systems to meet goals with small staff.
Procurement/ Support	Over 40 buildings; 1200 - 1400 Lexitrons and 25 PRIME 2250s; expert system for preparing RFPs.	Fewer buildings as some sold to employees; agency wide projects and resource tracking system.	New, modern location for EPA headquarters. Drop in volume of paper stored with move to laser disks.	Efficiency concerns paramount as drive to do more with less continues; privatization issue remains strong.
Planning	Printed reports backed up by improved graphics and data presentation; no MIS.	Integrated databases, especially administrative, create an agency Management Information System	Integration of databases, and an organic act improve planning; more specific and better cost/benefit analyses.	Vocal, contentious constituents combined with need to meet many statuatory responsiblities.
IMPLICATIONS				
Security	Security not a big concern; toxics data encrypted and walled off from other data.	American Pesticide suit challenges integrity of EPA data; ECOCARD and remote monitor tampering charges.	More audit trails and other methods to protect the physical and electronic integrity of EPA data.	Increased domestic and international economic competition drives concern over use of proprietary data.
Privacy	Confidentiality important but Supreme Court gives EPA right to use proprietary data to check other data.	Limits on Criminal Waste Handlers System; challenge to EPA use of EPIC photographic evidence; 134 drop out of ECOCARD program.	Continued matching despite challenges given strong public support for EPA; EPIC data use upheld.	More enforcement and better means of collecting and analyzing data increase the possibilty of unwarranted invasions of privacy.
Public Information	Not a high priority; embargo on most EPA documents; active groups can get information they want.	Improved reputation with the public because of more involvement; charges of sanitizing or witholding information.	More access with improved public involvement methods and widespread adoption of personal computers.	More home computers; more public concern with local environmental quality and its effects on health.

REFERENCES

1. The suggestion for this degree of penetration came from the workshop of EPA information and program managers. It is reasonable to assume given the plans outlined in the EPA ADP modernization plan.

2. AIRS is a planned database; the expansion of CERCLIS and STORET are more speculative. See EPA, "Major Information Systems Using Data Provided by State and Local Agencies" (mimeo) March 7, 1985.

3. See EPA, *ADP Modernization Program for the Environmental Protection Agency*, August 1983, p. 9.

4. EPASK is a fictional name for a hypothetical but plausible internal EPA electronic bulletin board.

5. EnviroNet is a fictional name for a hypothetical network of and federal environmental agencies. The network is not outside the projected technical capabilities.

6. NEMIS is a hypothetical name for the logical extrapolation of EPA plans to integrate databases; see EPA, "Major EPA Information Systems".

7. The staff comments are based on the workshop held in connection with this project at EPA headquarters.

8. These database descriptions are based on EPA, "Major Information Systems".

9. See EPA, Office of Administration, Office of Management Information and Support Services, *EPA Environmental Data Base and Model Directory*, July 1983.

10. Ibid.

11. Rochelle L. Stanfield, "Few Are Satisfied with Statues Aimed at Controlling the Chemical Revolution" *National Journal* (11/17/84).

12. "Trying To Speed ReRegistration" *Chemical Week* (7/4/84).

13. See EPA, *ADP Modernization Program*.

14. Ibid.

15. Ibid.

REFERENCES (continued)

16. Ibid.

17. See Rochelle L. Stanfield, "Ruckelshaus Casts EPA as 'Gorilla' in States' Enforcement Closet" National Journal (5/26/84).

18. See EPA, "Major Information Systems".

19. "Panel Suggests Management Changes at EPA" Chemical and Engineering News (6/4/84).

20. See Rochelle L. Stanfield, "Ruckelshaus Casts EPA as 'Gorilla' in States' Enforcement Closet" National Journal (5/26/84).

21. Robert Taylor and Andy Pasztor, "Reagan Administration's Deregulation Offensive 'Stopped in Its Tracks' on Environmental Issues" Wall Street Journal (1/8/85).

22. See Technology Review (October 1984).

23. See Rochelle L. Stanfield, "Ruckleshaus Casts EPA as 'Gorilla' in States' Enforcement Closet" National Journal (5/26/84).

24. See "After the Turmoil at EPA - The Successes and Failures" U.S. News and World Report (June 18, 1984).

25. See EPA, ADP Modernization Program.

26. This is a hypothetical but plausible report given the growing public concern over groundwater contamination.

27. See Vary Coates, Joseph F. Coates, and Lisa Heinz, Clues to the Environmental Future 1985 - 2020 Prepared for EPA, Office of Exploratory Research, Contract no. 68-02-3762, (Washington: J.F. Coates, Inc., December 1984).

28. Ibid.

29. This is logical projection given the efforts to integrate data base management throughout the agency. See EPA, ADP Modernization Program.

30. This is a hypothetical expert system which is well within the projected capabilities of this technology.

REFERENCES (continued)

31. This program reflects what several observers have cited as a major priority for EPA in the next decade; see EPA/ORD, Research Outlook - 1983.

32. ECOCARDs rae based on the currently commercially available technology of memory cards also known as smart cards.

33. See Brad Schultz, "IBM Introduces New High-End Mainframes" Government Computer News (3/8/85).

34. This is a reasonable extrapolation given the ADP modernization plans, the growing decentralization of the agency, the upgrade to IBM 3090 series, and the NIH data reported above.

35. This is a high end estimate of the number of states that could directly access EPA computers. It assumes widescale computer compatibility and upgrading within the states.

36. The panel is hypothetical but plausible as is the expert system for reviewing EISs.

37. This data exchange is hypothetical but could be the logical successor to the Chemical Information System; see Jeffrey Fox, "EPA Data Base in Turmoil" Science (3 August 1984).

38. This case and the insurance industry response are speculative intended to illustrate one possible way EPA could come into closer coordination with the private sector.

39. This rate of compliance is a high end estimate which assumes continued increases in the level and efficacy of enforcement.

40. This rate of court challenges is based on improvements in EPA enforcement activities and improved legal research capabilities.

41. The tracking program is hypothetical and meant to illustrate the possible movement of EPA in computer matching.

42. These improvements in EPIC are well within current DOD capabilities.

43. This level of negotiated rule making is beyond the estimated 10% of rules to which such procedures would apply. It assumes improvements in the process widen the applicability of the process. For more see David Hansen, "EPA Begins Pilot Program for Negotiated Rule Making" Chemical and Engineering News (9/17/84).

REFERENCES (continued)

44. All of these information dissemination programs are fictional and intended to illustrate the variety of things EPA could do. They are all currently technically feasible.

45. This is a reasonable extrapolation given the pressures to keep federal spending down.

46. This program is a reasonable extrapolation of the growing use of contract employees.

47. This is only a slight modification of the methods by which employees are buying steel plants and auto factories.

48. The TIGER file is a planned system at the Bureau of the Census; see that agency's Information Technology Plan 1984.

49. This system is hypothetical and would involve substantial improvements in current technology.

50. The need for another IBM 3090 is evident given the growing use EPA information technologies for federal and state environmental computing.

51. This is a reasonable projection given footnote 35.

52. This is a reasonable projection given footnote 39.

53. This is a reasonable projection given footnote 40.

54. This is a hypothetical case to illustrate the possibility of data security problems in EPA.

55. This is not implausible given the recent revelations of insider trading at the Department of Defense.

56. This is a hypothetical case to illustrate problems with maintaining the confidentiality of EPA data.

CHAPTER VI

BI-ANNUAL REPORT TO CONGRESS ON INFORMATION TECHNOLOGY AND GOVERNMENT

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
THE SOCIAL SECURITY ADMINISTRATION

JANUARY 15, 1991

HIGHLIGHTS

For the Social Security Administration this has been a decade of progress. It is once again a leader in the use of information technology for government operations. A 1970s study noted that agencies with large volume routine operations such as Social Security were among the first to adopt information technology.[1*] Such was the case with the Social Security Administration (SSA); it adopted automated data processing in the 1950s and enjoyed a long steady expansion in technical capabilities (Exhibit 16). However, technology and other agencies passed the agency by until in the early 1980s the SSA information technology system was approaching a disastrous operational situation. Backlogs of several years in benefit recomputations were common; skilled programmers were leaving the agency faster than they were joining it; 150,000 files were moved manually every month; Cost of Living Adjustments (COLAs) took four months and 20,000 person hours to enter into the system.[2]

With the support of the Administration and Congress, SSA developed and implemented a Systems Modernization Plan (SMP) in the early 1980s. Over the past ten years this plan has modernized the central computer processing system, shifted data storage from tapes to on line, modernized the extensive communications network linking headquarters with the field, set up state of the art information processing facilities in the field offices, and, most important, created a modern software system to run these new systems.

To celebrate ten years of the Systems Modernization Plan, SSA recently held an awards dinner. Exhibit 17 is a sampler of the comments of a roundtable discussion of senior employees on the effects of information systems modernization on SSA.

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* References, which are at the end of the scenario, give the source, logic, or explanation for illustrations, projections, or assumptions.

Exhibit 16

EVOLUTION OF SSA SYSTEMS

1937-1955 - the clerical/eam era

pre-adp operations

- early use of clerically maintained ledger files
- use of clerically maintained flexoline files
- development of eam (punchcard) capabilities
- establishment of large punchcard files in payment centers and central office
- operations highly factorized and functionally independent

1956-1962 - the conversion phase

adp systems phase i

- acquisition of the first computer for central operations
- acquisition of computers for payment center operations
- conversion of eam card files to edp tape files
- operations remain factorized and decentralized

1963-1965 - the development phase

adp systems phase ii

- development of computer processing capabilities
- installation of telecommunications system
- centralization of payment center large scale computer operations
- limited development of subsystem linkages
- development and approval of ssa's total data system plan

1966-1974 - the integration/expansion phase

adp systems phase iii

- extensive expansion and refinement of adp capabilities
- extensive integration of subsystems
- improvement of master file structure, content and use
- direct input of basic data from district offices and payment centers to central office computers
- establishment of adp control over processing workloads
- access to master file data made available to district offices and payment centers

1975-1981 - the hiatus phase

adp systems phase iv

- emphasis on maintenance of existing systems
- limited development of new or expanded capabilities
- limited acquisition of new state-of-the-art technology

1982-ongoing - the modernization phase

adp systems phase v

- release of the commissioner's systems modernization plan (smp)
- initiation of smp development and implementation activities
- extensive achievements during first year of smp
- groundwork laid for fully successful implementation

Exhibit 17

AWARDS DINNER COMMENTS: TEN YEARS OF SYSTEMS MODERNIZATION AT SSA[3]

- Modernization has enabled the agency to improve the efficiency of its operations — that is, to carry out our mission more cost effectively and to deliver fair and equitable service to all of our clients.
- Modernization has enabled us to attract more and better people to work with us.
- Information technology has improved the processing of benefits, the posting of earnings, and the verification of records and claims.
- Modernization increased our ability to serve the public quickly and accurately by having on line access to data essential to determining benefits and issuing payments immediately upon receiving notice of changes.
- We have significantly reduced the burden placed on benefit recipients by relying on more electronically provided data.
- We are now paying correct benefits to entitled people within five days after they have filed for those benefits.
- SSA has increased the accuracy of its benefit paying processes to 99.5% while also providing the public with direct access to file benefit claims.
- The work environment has improved as more employees have had a role in decisionmaking.
- We have made a major reduction in paper processing and have cut the volume of new paper stored by 50%.
- Our ability to target legislative changes more efficiently on the problem being addressed and to rapidly implement such legislative changes was improved by information technology.
- SSA saved the taxpayers hundreds of millions of dollars by becoming much more efficient.
- Without the new technologies, the agency may have collapsed.
- SSA is a better place to work.

The specific steps Social Security Administration has taken in the past decade to improve its service to the public include:

- Replacement of 11 outdated central processing computers with four more powerful computers;[4]
- Putting the Master Beneficiary Records and other large files online;
- Documenting all software and replacing the older programs with more universal languages;
- Upgrading all aspects of the Social Security Administration's Data and Retrieval System (SSADARS) from new terminals to more front-end processors and more powerful host computers.
- Growing use of teleservice centers for filing claims, introduction of automated teleservice centers, and a National Information Center able to handle requests in 63 languages;
- Modernization of claims processing in 1300 district offices by introducing computer driven, expert systems approaches to interviews, benefit computation, and notice preparation. This helped the field offices cope with the transition to a two-tiered benefit system in 1989;[5]
- Computer based training for all field claims representatives including modules using Hammond Judgment Theory to improve employee awareness and improvement of judgment skills;[6]
- Implementation of mandatory magnetic tape filing of annual earnings reports by companies with over 1,000 employees;
- Increased use of matching with state, local, and commercial computer records to locate overpayments. A prime example is Project GOGOL, which is nearing completion;[7]
- Replacement of paper social security cards with Social Security Smart Cards (SSSCs) with imbedded microchips. In addition to making the cards harder to counterfeit, the SSSC maintains an up to date posting of lifetime earnings which can be used to verify SSA records and benefit computations;[8]
- Movement from a relatively passive response to beneficiary demands to active search for possible beneficiaries.

As a result of these information technology driven changes, many facets of the SSA system have been improved:

- Timeliness - Social Security cards are available on demand; benefit checks are mailed within five days of receipt of application, in all but the most unusual cases; earnings are posted in an average of five months.[9]
- Accuracy - Error rates have been reduced on all programs, including state AFDC payments. SSA records and beneficiary SSRC's agree on lifetime earnings in 99.7% of cases.
- Efficiency - Systems modernization has reduced the administrative costs to $0.01 for every $1.00 of benefits. For example, individual SSA programmers now manage an average of 80,000 lines of instructions; ten years ago the average was 20,000 lines per programmer.[10]
- Complexity - Legislative changes have continued to make benefit computations more complex -- especially the shift to a two-tiered benefit system in 1989. Only 0.4% of appeals decisions related to the two tier benefits have changed SSA benefit computations. With an upgraded Management Information System, SSA can give better, faster, more accurate estimates of the effects of legislative changes on the beneficiary population, on the trust funds, and on SSA operations.
- Responsiveness to Public Needs - SSA has increased the quality of service to the public through electronic bulletin boards, more audio-visual presentations on Social Security on FEDNET the federal cable TV network,[11] more use of appointments in District Offices, and more accurate judgments on which cases or appeals to pursue. For example, in disability claims the percentage of SSA judgments reversed by higher courts has dropped from 34% to 11.3%.
- Overpayment - Through more aggressive matching and automated debt collection, SSA has reduced the amount of overpayment from $4.51 per $1000 to $2.23 per $1000.[12]

- Underpayment - With growing awareness of beneficiaries rights as evidenced by the mandamus issued by Judge Gray in 1988, increased computer capabilities, and cuts in benefits came legislation for SSA to actively seek out beneficiaries. The Seniors Registration Program has in two years registered 96% of the population over 65. As a result of the program, over one million beneficiaries were added.[13]
- Employee quality - With the resurgence of SSA leadership in the use of information technology, the agency is able to attract and retain qualified programmers. As many clerical jobs have been removed, the skills of many SSA employees have been upgraded.

The Future of SSA Information Technology

As SSA has improved its information processing capabilities, pressure has grown to give SSA more responsibilities. Challenges and opportunities SSA is likely to face in the next five years include:

- Managing the effects of comparable worth legislation
- Moving to total electronic storage
- The finite lifetime of data on disks
- Continued need for improved electronic security
- More challenges to SSA projections and models
- Changing nature and pattern of disability in the contemporary information society
- Responsibility for a Unified Federal Pension System
- Public concerns over computer matching and identity cards

These are the price of successfully remodeling SSA information technology. The greatest challenge remains getting the right check, in the right amount, to the right person at the right time. SSA will need to keep up with changing technology, changing public attitudes about individual privacy, and the changing needs of beneficiaries.

The next four sections elaborate on the above highlights by describing SSA in 1985, the developments from 1985 to 1991, developments anticipated by 1995, and the consequences of these changes for security, privacy, and provision of public information.

INFORMATION TECHNOLOGY IN THE SOCIAL SECURITY ADMINISTRATION: 1985

Public Law 100-16, the Citizens Security Act, requires each agency to report on the effects of developments in information technology on its functions since 1985. In order to provide perspective on the changes wrought by information technology this section describes the use of information technology at SSA in 1985. The discussion uses the functional categories outlined in the Citizens Security Act. After stating the mission of the Social Security Administration, the discussion turns to those functions for which information technology has the most direct and planned significance: information collection and analysis, information dissemination, disbursement and related services, and auditing and monitoring. The discussion then covers other agency functions: coordination, planning, personnel, support services, and procurement.

Mission

The mission of the Social Security Administration in 1985, as it is today, was to provide Old Age, Survivors and Disability Insurance (OASDI) benefits when workers retire, become disabled, or die. SSA also administered Supplemental Security Income (SSI) to the aged, disabled, and blind and part of the Black Lung Program. In 1977 responsibility for Medicare was shifted from SSA to the Health Care Financing Administration. In addition to these programs SSA was also responsible for providing federal funds, policy, and guidance to the states in the administration of Aid to Families with Dependent Children (AFDC) and Low Income Home Energy Assistance. To support these programs, SSA provided:

- research and recommendations on poverty and other matters relating to the aged, blind, and disabled,
- planning, design, and implementation of automated data processing,
- statistical measurement and systematic evaluation of agency operations,
- public information on programs and administrative procedures,
- policy guidance,
- benefit payments.

Social Security Administration operations involve billions of dollars and millions of people. In 1984,

- OASDI programs had 36.3 million beneficiaries receiving over $174 billion in benefits — $157 billion for old age and survivors benefits and 17.6 billion for disability benefits.
- SSI had four million beneficiaries, many of whom were also on OASDI rolls; they received $8.9 billion in benefits.
- AFDC payments were $12.4 billion to an average monthly caseload of 10.4 million people.

Two thirds of SSA beneficiaries were over 65; 70% of Americans over 65 had had some personal contact with SSA at some time in their lives. Moreover, two out of three older Americans depended on Social Security for at least half of their income.[14]

To do the administrative work involved in paying almost $200 billion a year to 50 million people all over the U.S. and in other countries, the Social Security Administration had an extensive field network consisting of:

- 1340 district offices under the direction of 10 regional offices,
- 34 Teleservice centers,
- 3150 contact and resident stations where SSA provided part time service to smaller remote areas,
- 3 Data Operations Centers where data from source documents is put in electronic form,
- 6 Program Service Centers and the International Program Service Center (INTPSC) which certify benefit payments, maintain beneficiary records, review selected claims, collect debts, and provide other services to district offices and the public,
- 135 hearing offices employing over 700 administrative law judges under the direction of 10 regional chief administrative law judges and a chief administrative law judge,
- Headquarters consisting of staff offices, a National Computer Center, disability operations, central records maintenance, and INTPSC.

Information Collection and Analysis

Most of SSA's operations involve collecting and processing information in the form of survivor, retirement, or disability claims, requests for hearings, posting of earnings, and computation of benefits. In 1982 the problems with these core SSA operations were severe enough for the Commissioner to write:[15]

> Twenty years ago the Social Security Administration's data processing system was a model. Burgeoning workloads and the failure of past responsible leaders ... have brought the Social Security Administration to the height of inefficiency in managing its programs. Billions of dollars are wasted; services to beneficiaries are too often limited or nonexistent; opportunities for fraud and abuse too often exist. We are too often unable to respond to changes in law or procedures to provide needed services.

Between 1982 and 1985 great strides were made to improve the information processing capabilities of SSA. Few agencies had revised their information systems so completely and few agencies had needed to as much. To review the status of SSA's information system in 1985 the following sections discuss the situation in the various components of the SSA network.

Field Offices: SSA helps the elderly, disabled, and surviving family members; it is essential that such service be provided as humanely as possible. For this reason, in 1985, as now, the field offices were most important element of the SSA network. In 1984 these district offices took in over 7 million OASDI and SSI claims and more than 8.3 million requests for Social Security numbers (SSNs). In most field offices the receipt and processing of applications was done manually. In most offices people were served on a first come, first serve basis. Information was forwarded to the Regional Offices, the Program Service Centers, or headquarters over the SSADARS (see below). Benefit computations were sometimes done by individual claims representatives using programmable calculators.

The 34 Teleservice Centers supported the work of the District Offices by providing information on SSA programs over the phone. To relieve the burden on the District Offices, SSA encouraged people to phone rather than visit. For those people who visited, some offices experimented with setting up appointments. One group of representatives handled appointments while another group handled the walk-ins.

Early 1985 saw the beginning of big changes for the District Offices. The York, Pennsylvania and Baltimore (downtown) offices were the first offices to get extensive computer equipment for claims processing as part of the Claims Modernization Program. Associated with this program was automation and upgrading of much of the office equipment in the District Offices (the Field Offices Systems Enhancement).

Other Offices: The Program Service Centers (PSCs) assisting field offices had central computers for storing records, handling difficult claims, and reviewing District Office decisions. Since these IBM 360/65 computers were almost 20 years old in 1985, some of the PSC workload was done manually. In 1984 and 1985 the PSCs received bar code scanners for use in tracking the movement of case folders; at any given time one million folders were in process in some PSCs.[16]

On disability claims, SSA worked closely with state Disability Determination Services (DDSs) which made the actual determination of whether a person was disabled. DDS operations were not automated in the early 1980s; a prototype of an automated case control and management reporting system for DDSs was developed in California by mid 1985. Hearing offices of SSA administrative law judges handled over 200,000 cases in 1984 — almost all of which involved disability claims. The case tracking for hearing offices was largely manual until bar code scanners were installed in 1984 along with a more general move to automate hearing offices.

SSADARS: The SSADARS was and still is the communications network which knit these different types of offices together. In 1985 SSADARS handled 2,050,000 transactions daily of which 800,000 were considered critical such as verification of identity, past records, computations, or other claim actions from SSA headquarters.[17] In the early 1980s, the aging equipment of SSADARS -- terminals, modems, trunk lines, concentrators, front end processors, and host computers —

meant extensive downtime and delays. SSADARS was down an average of 11% of the time almost always as a result of hardware failures. This led to restrictions on use of the system at peak hours which meant slower service to applicants. The problems were alleviated somewhat by 1985 with the installation of new concentrators and host computers with four times the power of the previous systems.

Headquarters: The biggest bottleneck in the SSA system in the early 1980s was the computer system at headquarters. Headquarters information systems housed all central records of payments, beneficiaries, and earnings, and social security numbers. As a result of incremental, stopgap measures taken over 20 years the headquarters computer system had become more of a hindrance than a help. For example, in the early 1980s:

- production schedules were met 45% to 75% of the time;
- a fourth of all jobs had to be rerun;
- 150,000 tapes were handled manually every month;
- earnings were not posted until 15 months after receipt;
- it took 4 - 6 weeks to get a Social Security Number;
- for older programs, programmers could manage only 10,000 to 12,00 lines of instructions compared to an industry average of 60,000 lines;
- benefit recomputations dating back to 1978 remained undone.

The Systems Modernization Plan attacked these problems by upgrading software, hardware, and database management systems:

Hardware: Six outdated IBM S370 mainframe computers were replaced with three IBM S3081/K mainframes. This increased the computing power from 14 Million Instructions Per Second (MIPS) to 45 MIPS.[18]

Software: Old software was documented and clear logic paths established while new software was developed for the test and timesharing facility in order to develop and test new and improved software for programatic use.

Database Managment: Half the files including the SSN files, the Master Beneficiary Records, and the Supplemental Security

Records were online in 1985 allowing direct and quick access for computations, recomputations, and verifications. Also SSA asked larger companies to provide earnings records on magnetic tape instead of on paper.

These changes had had a significant impact on the quality of SSA operations. By 1985:

- earnings were posted in an average of 11 months;
- SSNs were available in 11 days;
- manual tape moves had been cut by almost one third;
- The time between application and payment for OASI had declined from 32 days in 1982 to 26 days in 1983;
- Application to check time for SSI was 18 days for those over 65 in 1983, down from 24 days in 1982.

Still, problems of backlogs and downtime continued to plague information collection and analysis. Improvements in the field offices and the SSADARS as well as economic and demographic changes increased the burden on the central information system. In 1984 the SSA central system workload was 5000 CPU hours a month; 2000 of these CPU hours were for critical tasks such as paying beneficiaries.[20] Largely because of a lack of data processing personnel, the workload continued to exceed the capacity of the system.

Information Dissemination[21]

Most of the information that SSA provides to the public concerns SSA programs, polices, and procedures. SSA produced more than 100 million copies of 50 publications in 1983. Many of these explained the basics of Social Security, SSI, and Medicare. Also, District Offices handled over 40 million inquiries. The headquarters Office of Public Inquiries handled 147,000 priority inquiries: 39,000 on disability, 29,000 on hearings and appeals, 22,500 on OASI, and 6,000 on SSI.

More people were using the telephone to get information on Social Security; there were 21 million phone inquiries in 1983. SSA was experimenting in 1985 with automated teleservice centers like those operated by the IRS which provide routine tax information.

Perhaps the most common method of communicating with the public was through notices and other information enclosed with benefit checks. A priority issue for SSA at the time was improving these routine enclosures since poor writing and formatting often led to more confusion than clarification. Part of the Claims Modernization Program involved automating the issuance of notices using standard paragraphs.

In addition, SSA produced films, broadcast and cable TV spots, and radio programs describing benefits and how to get them. In some areas, SSA representatives appeared live on phone-in shows. TV and radio spots and teleservice messages were available routinely in Spanish. In the case of some notices, Hispanics were asked to call the local office for further explanations in Spanish.

Disbursement

In addition to sending out information, SSA also disbursed checks, Social Security Cards, and in a few cases cash. In the case of benefit checks, SSA did not actually send out the checks; they authorized the Financial Management Service (FMS) of the Department of the Treasury to send out the checks. This usually meant the Program Service Centers provided computer tapes of amounts, recipients, and addresses to an FMS Regional Disbursing Center. In cases of obvious need, District Offices were authorized to provide up to three months of benefits in cash to new SSI beneficiaries.

Beginning in the mid 1970s SSA and FMS began to promote the use of direct deposit of benefit checks to financial institutions. Since this could be done electronically it saved paper, postage, and labor costs. By 1983 40% of beneficiaries were taking advantage of direct deposit. Retired people with high benefits were most likely to use direct deposit; SSI recipients were least likely to use direct deposit.

P.L. 98-21 required that beginning in October 1983, Social Security Number Cards be made of banknote paper in order to deter tampering and counterfeiting. Reducing the number of duplicate numbers was very important in improving the quality of SSA earnings and benefit data and thus avoiding overpayments. The new cards were only used for new applicants and for replacement of lost cards; no one with an old card needed to get a new card.

Audit and Monitoring[22]

Paying over $200 billion a year to 50 million recipients requires extensive auditing and monitoring to make sure that the money is being properly spent. During the information systems crisis of the late 1970s audit and monitoring functions were left behind while SSA focused almost exclusively on meeting its critical functions. With the upgrading of the information systems came renewed attention to these responsibilities.

Close behind the primary concern of timely and accurate checks at SSA was and remains overpayment. Paying too much or paying to the wrong people strains the resources of the Trust Funds and the General Revenues. The overpayment problem with regard to OASI was relatively small in 1985 -- overpayments of $4.51 for every $1,000 of benefits. Most of these were the result of unreported earnings by beneficiaries; these overpayments, once discovered, were easily recouped by reducing future benefits. The overpayment rate was higher for SSI -- $36 per $1,000 of benefits. Simplification of SSI application procedures helped to reduce this error rate.

In the disability area, auditing was particularly complex. State DDSs made all disability determinations; SSA was required by law to review 65% of all DDS determinations favorable to the beneficiary before paying. In 1983 SSA reversed 2% of the favorable determinations. In addition SSA Field Assessment Offices in the 10 regions did reviews on both favorable and unfavorable decisions. People who were not satisfied with the disability determination by the state agencies could appeal to administrative law judges, the Appeals Council and to the federal courts. In FY83, 34% of the final court orders on disability reversed DDS/SSA determinations.

In the area of Aid to Families with Dependent Children (AFDC), SSA provided oversight for state programs. The overpayment rate in AFDC programs was $73 per $1,000 of benefits in 1981-1982, down from $165 per $1000 in 1973. For FY81, 28 states faced the loss of federal matching funds as a result of failure to meet error rate targets. One way SSA attempted to assist the states was to provide incentive funding for automated management information systems dealing with AFDC administration. For example, SSA contracted with North Dakota to implement a system that had been developed in Alaska.

An important facet of SSA monitoring activities was computer matching. To improve accuracy and reduce waste and fraud in the AFDC area, SSA promoted the use by states of a wide variety of data including SSA earnings data, state unemployment compensation data, motor vehicle registration data, state income tax records, and vital statistics records. For its own use, SSA expanded the use of state death records and federal death records matched with SSA benefit rolls to identify payments to deceased beneficiaries. In exchange for the data, SSA provided access to SSA data for federal and state funded programs.

Once SSA identified an overpayment, the problem of collecting the debt remained. In cases of excess earnings the debt could be taken out of future benefits. In other cases, SSA was beginning to experiment with automated debt notices. Overall, SSA collected $6.33 for every dollar invested in collection.

Coordination

SSA worked and continues to work closely with the States on all SSA programs because in many cases they overlap, supplement, or substitute for state programs. In the disability area, state DDSs are responsible for making disability decisions. AFDC is a state run program directed, in part, by SSA. To assist the state agencies it works with, SSA has actively promoted information technology systems developments and transfer among states. This ranged from seed money to conferences on management information systems.

Within the federal government, SSA works most closely with the Financial Management Service and the Internal Revenue Service of the Department of the Treasury. In both cases most communication was electronic in 1985. SSA also deals with many other state and federal offices -- Veterans Administration, Immigration and Naturalization Service, State Bureau of Vital Statistics, State Department of Vocational Rehabilitation, State Department of Corrections, and others. SSA designates certain District Offices as "parallel" offices responsible for coordination with the local or regional offices of these many different state and federal offices.

In addition to state and local governments, SSA also has many contacts with foreign governments. As one of the oldest and largest Social Security systems in the world, SSA provides consultation, training, internships, and even actuarial reviews to other nations' systems. In addition, SSA has agreements with other countries to share information in order to reduce dual coverage and taxation for those who work in the U.S. and in foreign countries. By law, social security benefits are available to anyone who works or has worked in the U.S. whether they are a citizen or not.

Planning

SSA planning and management information systems suffered when the agency's attention was focused largely on meeting the critical functions with outmoded and archaic hardware and software. This promoted a crisis atmosphere that was not conducive to long range planning. Frequent changes in top leadership -- eight commissioners in ten years -- and four major reorganizations between 1975 and 1985 hampered effective planning.

Yet, SSA continued to provide long range projections on the future of the trust funds and of the demand for benefits. These estimates were widely criticized as being much too optimistic; eventually the 1983 Social Security Amendments put the system on a more realistic basis. One of the factors contributing to the criticism of SSA projections was the lack of sufficient computing power dedicated to running simulations and models for projecting the future of the system. Also contributing was the lack of timely information on the performance of the system or of the trust funds.

Personnel

SSA employed 74,145 people as full time permanent staff in

1984. In addition SSA used part time and temporary workers for another 15,000 workyears annually; many of these worked in contact stations in smaller remote areas or at teleservice centers.

Of the full time employees, 8,000 were involved wholly in data processing. In the early 1980s there was a critical problem with the loss of programmers. In 1980, 112 of 560 programmers left; only 21 were replaced. Since many of the older files were not documented, when programmers left they took with them the experience for dealing with these undocumented, patched together programs.

Since almost all SSA employees were involved with information systems, the massive changes instituted under the Systems Modernization Plan had wide ranging effects. One of the Commissioner's eight goals in 1985 was to manage the human effects of this automation by upgrading the skills of those affected. This upgrading included computer based training to improve employee awareness and enhance computer literacy as SSA moved to using more information technology.

Support Services

Security focused on physical security of computer facilities to prevent unauthorized access as well as theft of equipment. Electronic security measures were less prominent. Part of the move to improve physical security was the consolidation of all computer operations at headquarters in the National Computer Center.

Supplies were managed by the Social Security Supply System — an information technology supported logistics system. Increased requirements and reorganizations created more work than the system could handle by 1985.

INFORMATION TECHNOLOGY AT THE SOCIAL SECURITY ADMINISTRATION - 1991

This section discusses the changes in the use of information technology at the Social Security Administration since 1985. At the beginning of this report, the key developments were highlighted. This section expands on those highlights. The discussion follows the same format as the 1985 discussion -- beginning with the mission and moving to key information technology functions of information collection and analysis, information dissemination, disbursement, and auditing and monitoring. It finishes with other functions — coordination, personnel, procurement and support services, and planning. These changes and the forces driving them are summarized in Exhibit 18.

Mission

The mission of the Social Security Administration (SSA) remains largely the same as it was in 1985 -- providing insurance (OASDI) benefits when workers retire, are disabled, or die. SSA continues to be responsibile for Supplemental Security Income (SSI) and the federal share of Aid to Families with Dependent Children (AFDC). Information technology advances have significantly improved the ability of SSA to meet its mission in a timely, accurate, and equitable manner.

There have been two significant information related changes in the SSA mission since 1985. As a result of growing benefit rolls and slower growth in the working population, the trust funds continued to experience financial difficulties in the late 1980s. To deal with these problems, The Social Security Recovery Act of 1988 instituted a two-tier benefit system.[23] The benefits paid to beneficiaries added to the rolls after September 30, 1989 are calculated at a lower rate than those entered on the rolls before that date. SSA's modern information systems were able to handle this added complexity with little difficulty.

The package of Social Security reforms introduced with the two-tier system included a program for locating and paying people entitled to benefits but not currently on the benefit rolls. This was concurrent with the mandamus issued by Judge Gray in early 1988 requiring SSA to take more active steps to secure the rights of beneficiaries. To locate beneficiaries, SSA instituted a Seniors Registration Program; all citizens are required to register with their local Social Security Office within 180 days of their 65th birthday. Failure to register can lead to reduced benefits. All those over 65 when the program was instituted were given a year to register before losing benefits; those already receiving benefits were not required to register. People can register in person, by phone, or by letter. As part of the registration, SSA verifies employment and earnings histories and thereby updates its Master Beneficiary Files. By December 31, 1990, 96% of all eligible citizens were registered; more than one million beneficiaries had been added to the rolls. The registration drive could not have succeeded without the intelligent terminals at the District Offices, the expanded capacities of SSADARS, and the improved software and data management capabilities of the National Computer Center (NCC) at headquarters. For example, SSA launched an extensive automated direct mail campaign using its computer files and those of state and local agencies such as state Motor Vehicle Administrations to notify citizens of the registration program.

Information Collection and Analysis

The modernization begun in the early 1980s has come to fruition in the early 1990s. SSA has a modern information collection, retrieval, analysis, and dissemination system -- a system that is among the most efficient and effective in the nation. In all facets of SSA operations, information technologies have enhanced the ability to get the right check to the right person at the right time. Most of the changes in the SSA information systems were underway by 1985; the following sections describe how the different parts of the SSA system changed between 1985 and 1991.

Field Offices: The field offices remain the primary point of contact with the beneficiaries and the public whether it be collecting survivor benefits, applying for a Social Security Smart Card (SSSC), registering in the Seniors Registration Program, or filing a disability claim. The modernization of the claims system begun in the mid 1980s has been completed; all offices are equipped with intelligent terminals with direct access to all needed files. There is now a terminal for every two claims representatives.[24] Portable terminals have been provided to the many remote contact stations. These terminals give on line access and quicker computations and applications thereby substantially enhancing SSA service to many parts of the country. Travelling claims representatives also use these portable terminals.

Expert systems programs such as COMPASS and APPLIQUE have made computations and applications more reliable and more efficient.[25] APPLIQUE guides the interviewer through the application queries while noting possible sources of error, fraud, or abuse. It also matches data provided with that from files from other federal, state, and local agencies to verify the information being given by the recipient. COMPASS helps claims representatives compute the benefits a person should receive by guiding the representative through nested questions designed to find the specific benefit category into which the person fits. COMPASS was particularly valuable during the introduction of the two-tiered benefit system. With the introduction of these programs, the disparities among district offices and between claims representatives has declined as has the need for recontacts and additional interviews.

The teleservice centers now account for 73% of all contacts. There are 75 teleservice centers — one in every state and most major cities. These teleservice centers can do everything District Offices do, from taking applications to computing benefits to providing general information.[26]

Other Offices: The Program Service Centers have been automated as part of the Claims Modernization Program. The central computers in the PSCs have 32 times the capacity of the systems in place in 1985. All files are scanned by bar code readers and automated file cabinets and robotics have replaced much of the manual file handling.

The state Disability Determination Services (DDSs) have increased their level of automation though not to the level of SSA District Offices or PSCs. Over half of the DDSs now have automated case control largely as a result of the incentive funding and technology transfer efforts of the SSA. The DDSs are one node in the emerging Disability Network.[27] This network provides instant communication between all the offices involved in disability issues -- SSA headquarters, the Regional Offices, the District Offices, the PSCs, and the DDSs. This network uses the facilities of the SSADARS but has its own terminals, software, and security procedures. The value of the network is in the ability to coordinate the actions of these many actors in making final disability determinations. The result has been a sharp reduction in the reversal of SSA determinations (see below under Audit and Monitoring).

SSADARS: The Social Security Administration Data and Retrieval System and its successor the Data Communication Utility (DCU) have become even more essential since 1985. With the modernization of the claims process and the disability hearing process has come a growing burden on the communications system linking all of the different types of offices together. The average daily transaction volume has grown to 1,800,000 transactions of which 1,200,000 are considered critical.[28] Fortunately, the host computers and backup concentrators installed in 1985 have been able to handle the load. There are some signs of trouble on the horizon however; waiting times at peak hours are beginning to increase and downtime, once as low as 3%, is up to 5%.

Headquarters: Headquarters is no longer the bottleneck in the SSA system. Expanded hardware, software, and database management capabilities have dramatically improved the quality of headquarters' service to the District Offices. SSA now has modern information processing facilities that enable SSA to:

- o meet production schedules 90% of the time
- o rerun only 4.3% of all jobs
- o move only 20,000 tapes a month
- o post earnings within 5 months[29]
- o do benefit recomputations within a week.

The specific improvements in the information systems which enabled such quick and accurate service include:

Hardware: The mainframes in place in 1985 were relatively new due to recent upgrades — four Amdahl 5860s, one Amdahl V/3, two NAS 9060s, and a Univac 1100/83. These have been continually upgraded to provide a current computing capacity of 140 MIPS, almost double that of 1985.

Software: Perhaps the greatest changes have been in the quality of SSA software. With a move to more standard languages and replacement of many of the older programs with more modern programming language, the average programmer can now manage 80,000 lines of instructions — the industry average. Moreover, with improved timesharing and testing facilities, creation of new programs has increased. Now less than half of programmers' time is spent maintaining software compared to 2/3 in 1982.[30]

Database Management: All routinely used files are now on line in Global Direct Access Storage Devices such as IBM 3380s. This has reduced the number of tape moves by 82% since 1985. Those moves that remain are done using remote controlled tape handlers. These two changes reduced the number of people involved in tape handling from 200 in the early 1980s to 20 in 1991.

Increased magnetic tape filing of earnings reports has improved the management of data. In 1988, Congress amended the Social Security Act to levy a penalty on all firms with more than 1,000 employees who failed to use magnetic filing. Now, fewer than 3% of such companies use paper filing. With the introduction of Social Security Smart Cards, smaller companies can file the electronic readouts from earnings meters as earnings reports (see Disbusement below for more).

Backlogs and downtime no longer trouble the information collection and anaysis operations of SSA. The use of the system has increased from 5000 CPU hours a month in 1985 to 6750 in 1991; from 3000 critical workload CPU hours to 4000.[31] Yet the quality of service has increased:

- o Social Security Smart Cards are available on demand;
- o Application to payment time for OASI benefits is 5 days;
- o Application to payment time for SSI benefits is 4 days.

Information Dissemination

Along with the general move to a more electronic society, the methods SSA uses for disseminating information have become more technology intensive. While SSA continues to send out 100 million copies of approximately 40 publications a year, more people are using electronic methods to get information about social security. In 1985, 50% of inquiries came in by phone; now more than 70% of inquiries are by phone. Of the phone inquiries, more than a third are handled by the automated teleservice centers. The recordings on these automated centers are updated every six months or as needed whichever comes first. Of the people who visit District Offices, four out of five have appointments; the average waiting time for those with appointments is 13 minutes while the average waiting time for walk-ins is 39 minutes.

With the growth of computer literacy in the general population, the demands on SSA for faster, more effective service have increased. In response to these growing demands, the District Office in St. Paul, Minnesota set up the first electronic bulletin board for social security recipients in 1987. Using personal computers and modems people can dial up the bulletin board, read messages from SSA on benefits and other programs, and enter their own messages or requests. In addition to establishing and updating the bulletin board, the District Office supplied several local libraries with terminals and training packages for helping citizens who wish to use the bulletin board. The response was so positive that similar bulletin boards have developed in 43% of the District Offices. Putting electronic bulletin boards in every District Office is under consideration.[32]

The language problem has increased for SSA. SSA has routinely served the needs of the Hispanic community by providing claims representatives fluent in Spanish. Now the Vietnamese and Koreans are seeking similar treatment. One SSA response is the National

Information Center. By calling an 800 number, a person can get a claims representatives who speak his or her language. The Center has experts in 63 langauges; a language is added every 60 days.[33]

Disbursement

SSA continues to provide the public with checks, cash, and Social Security Cards. Up to six months of benefits are available in cash from District Offices for those who are in dire need. Checks continue to be sent out by Treasury's Financial Management Service. FMS and SSA have increased the use of direct deposit of social security benefits to 65% of all recipients -- 83% of all OASI recipients. One of the forces behind this growth was the explicit introduction of a policy of paying direct depositor benefits three days before those who continue to receive paper checks.

The biggest change in disbursement is the Social Security Smart Card (SSSC). Continued problems with counterfeit numbers and several class action suits against SSA over earnings records discrepancies led Congress to institute a new Social Security identity system. The basis of the system is a plastic card with an imbedded microchip. This microchip can be written on or read only by authorized devices. Every payday, employers write employees' earnings on their SSSCs with a Pitney Bowes earnings meter leased from their local SSA District Office. Every three months readouts are sent, electronically, to the SSA District Office. The cards are difficult to counterfeit or alter without leaving a trace; the penalties for counterfeiting or unauthorized writing on an SSSC include steep fines and mandatory jail terms. Also, the SSSC is the employee's personal record of his or her earnings history, which can be used to verify and challenge SSA figures.

Auditing and Monitoring

Continued trust fund financial difficulties, the move to a two-tier benefit system, and growing public concerns over the equity of the Social Security system have increased the pressure on SSA to run an efficient and fair operation. Overall administrative costs have remained low -- about $0.01 for every $1.00 in benefits. The critical issue for SSA is, as it was in 1985, overpayment. With the improved software for matching, the introduction of APPLIQUE and COMPASS, and with the use of magnetic tape and earnings meter readouts for posting earnings, SSA has substantially reduced overpayments in all areas:[35]

- o OASI - $2.23 per $1,000 benefits, down from $4.51 in 1985;
- o SSI - $10.43 per $1,000 benefits, down from $36 in 1985;
- o AFDC - $24 per $1,000 benefits, down from $74 in 1985.

In 1986, Congress considered requiring SSA to pay interest on all underpaid benefits. Using COMPASS, the Seniors Registration Program, improved software and hardware for making benefit recomputations, and the introduction of SSSCs, SSA has virtually eliminated underpayments thus removing the need for Congressional action.

The quality of service in the disability area has also improved. An important spur to this improvement was the finding of the Supreme Court Commission on Federal Litigation that if more than 15% of an agency's determinations were being overturned by courts, the agency was putting an undue burden on its publics.[36] With automation of many DDSs and the introduction of the Disability Network, errors in computations and facts have decreased, placing more focus on errors of judgment. To assist in making disability judgments, SSA used over a thousand hearing officers, administrative law judges, doctors, and federal judges to create and expert system called DISQUE for disability queries. This system guides the claims representative or DDS staff through a series of diagnostic questions to reach equitable and accurate decisions. The result has been a decline in reversals of agency decisions from 34% in 1985 to 11.3% in 1991.

Improvements in the efficiency and accuracy of SSA benefit payments have been substantially enhanced by expanded computer matching with federal state and local sources. Project GOGOL was introduced in 1986 as an extensive search for deceased beneficiaries, using death records from states, counties, IRS, Medicare, Veterans Administration, and state and local courts. In the search for AFDC overpayments, SSA funded the introduction of advanced Management

Information Systems in more than 30 states. These systems enable these states to do extensive computer matching with federal records.

To collect overpayments, SSA has continued to automate collections by using computer generated first, second, and third notices as well as a modern accounts receivable system. In SSI cases, visits to beneficiaries' homes are required by law. SSA representatives use portable computers to record the data gathered on such visits. Overall, SSA collects $9.13 for every $1.00 allocated to collections.

Coordination

SSA continues to work closely with state and federal agencies in all of its programs. With the growing efficiency of SSA operations and the increased computing power at headquarters and in the District Offices, SSA has been able to expand its service to the states at no cost to the states. With expert systems such as COMPASS, SSA was able to offer the states more benefit computation options than it could before. These added options were most useful when the introduction of the two-tier benefit system significantly complicated the computation of state supplements — voluntary and mandatory.

In general, the ties between the states and SSA have become stronger as the states have increased their information technology capabilities and have become integral parts of the network of institutions dealing with social security benefit payments. In some states, however, automation has not kept pace with SSA developments. This presents problems for SSA as it continues to seek ways to reduce inefficiencies and inaccuracies in OASI, SSI, and especially AFDC programs.

On the international level, SSA is increasing its bilateral agreements with other nations concerning partitioning of benefits and taxes for workers who work in the U.S. and other countries. SSA by regaining leadership in information techology use has seen an increase in requests for internships, consultations, actuarial reviews, and other services. To help meet the demand, SSA is creating simplified versions of COMPASS, APPLIQUE, and DISQUE in English, French, German, Japanese, Chinese, Spanish, and Swahili. SSA is also providing training courses for foreign officials on modeling and simulation to support social security projections.

Planning

The improvements in information technology have revolutionized planning and analysis at SSA. Once again, SSA models and projections command the respect and attention of all those concerned with the future of the system. Increased computing power, better software, and improved management information have made SSA projections much more realistic than those of the early 1980s. Also, with the help of the expert systems program software, SSA is able to provide detailed, timely information to Congress on the costs, timing, and impacts of proposed legislative changes.

However, planning at SSA is at a crossroads. More groups are requesting access to internal SSA data so they can do their own analyses of the future of the system. Significant economic and demographic changes are altering the fundamentals of the system. One response is the recently commissioned Task Force on Disability in the Information Society. This task force is charged with exploring the implications of the shift from a manufacturing economy to a service and information based economy for the number and types of disabilities SSA will encounter in the future.

Personnel

Information technologies have been the major factor in changes in the number, type, and mix of employees at SSA:

- As a result of automation of many activities, SSA full time employees were reduced by 17,000 over the past six years -- mostly through attrition.[38]
- At the same time part time and temporary work has increased, as the number of teleservice centers has increased. The total workyears at SSA have declined by only 5,000 per year.
- The continuing demand for skilled programmers has begun to level off in recent years. SSA has been able to attract and keep more high skilled people as it has improved the technologies on which they work. Overall, the number of data

processing employees has remained around 3,000.

- With the growing use of computer driven programs in the field offices and in programming, there has been a concomitant increase in the use of computer based productivity assessments.
- The modernization of the claims process has also increased the need for computer literacy throughout the agency. Over 70% of the staff has had some computer based training.
- Many field officers have received computer based training on making judgments. Using the Hammond Judgment Theory, this training presents the respondent with multiple situations which duplicate work experiences. From their responses the program identifies the factors which enter into the officer's decision and the relative weight the officer gives to each factor.

Support Services

The supply system has been upgraded through the introduction of smart cards for automated supply handling. Each office has a supply smart card which it uses to get supplies from the automated supply room. This keeps track of who uses how much of what and of the overall inventory of supplies.

Security continues to concern SSA. The National Computer Center is increasingly seen as a vulnerability in the event of disaster -- natural or man-made. As a result a number of files and operations are being moved to other parts of headquarters and to different parts of the country. More important, there are growing concerns over electronic security. SSADARS field to headquarters communications are now routinely encrypted. Any computer based actions leave an audit trail for subsequent review. Authorization numbers are changed frequently and access to different types of files is strictly controlled. Despite these precautions there have been problems such as the recently discovered "kickback scam" (see below under Security). This will continue to be an area of substantial activity in SSA in the future.

INFORMATION TECHNOLOGY AT SOCIAL SECURITY: A LOOK TO 1995

While the Social Security Administration has made magnificent strides since 1985, changes and improvements are still needed. This section describes information technology related changes proposed for the next four years. As with the previous two sections, the discussion begins with the mission, moves to key information technology related functions -- information collection and analysis, information dissemination, and auditing and monitoring -- then finishes with a discussion of other functions -- coordination, planning, personnel, and support services. The changes are summarized in Exhibit 18.

Mission

The mission of the Social Security Administration will remain much as it is today — providing benefits when workers retire, are disabled, or die. Retirement benefits will continue to be the primary type of benefits and disability will continue to be the most contentious and litigious area.

SSA is likely to accumulate additional responsibilities. With its improved information collection and analysis systems, SSA seems the logical candidate to administer the Unified Federal Pension System (UFPS). The purpose of the UFPS is to consolidate the many different military and civilian pension systems under one program to get economies of scale as well as to limit the amount of pension a federal employee can receive. Some proposals call for limiting the total pension benefits to a federal employee to 65% of their salary (adjusted for cost of living increases) at the highest grade level they held for three years or more.[39] Other potential added responsibilities include Food Stamps and Draft Registration. The latter would build on the experience developed in the Seniors Registration Program. A potentially explosive issue for SSA is comparable worth benefits. SSA could be forced to recompute all OASI and disability benefits for women using a correction on previous earnings to account for inequities in pay. These changes could create extensive financial, administrative, and legal burdens for the agency.

Information Collection and Analysis

The collection and analysis of information at SSA will continue to improve as automation of more phases of SSA operations is completed. In the field offices there will be more terminals -- one for every claim representative. Portable terminals will be widely used in the contact stations. Other offices such as the Program Service Centers will have more terminals and upgraded computer facilities. By 1995 almost all state DDSs will have automated control systems and will be using DISQUE to do initial disability screenings. The relationship between field and other offices may shift with a growing move to regional distributed processing linked to a central file system at headquarters. Whether the system remains as is or moves to more distributed processing, SSADARS and DCU will continue to expand. The daily volume of transactions is expected to reach 2.1 million in 1995; 1.5 million of those transactions will be considered critical.[40] By 1995, the system will have several dedicated secure channels on the federal communications satellite FEDSAT.

Headquarters will also see increased workloads by 1995 -- 7500 CPU hours a month with 4500 CPU hours of that considered critical.[41] To manage the growing workload, headquarters will need to add at least two more mainframes in the 30-40 MIPS range -- one for SSADARS and one for other programmatic responsibilities. By 1995 all tapes will be converted to disk and will be on line. As SSA moves to total disk storage the issue of decay of data on disks will become more important, requiring increased testing and monitoring of seldom used disks. By 1995, earnings will be posted in a matter of weeks instead of months and the time between OASI or SSI applications and payment will be two days or less.

Information Dissemination

Most people will deal with SSA by phone in 1995. Of the anticipated 60 million inquiries, 90% will be by phone. Two out of every three calls will be handled by automated teleservice centers. By 1995 some centers will use voice activation technology and expert systems for automated telephone claims taking and benefit computation.

For people with access to computers, there will be electronic bulletin boards in all District Offices. These bulletin boards will contain electronic versions of APPLIQUE and COMPASS for automated applications and benefit computations.

The issue of language will continue to pose problems for SSA. A case currently before the Appeals Court may lead to a requirement for SSA to provide service in a particular language when 4% or more of the population of a service area speak that language. For example, several Los Angeles offices will have to offer services in Vietnamese and Korean.

Disbursement

By 1995 SSA will get the right check in the right amount to the right person at the right time 98% of the time. Direct deposit will account for 80% of all SSA payments; 90% of all OASI benefit payments.[42] This will come about because of increased concern over safety and security as well as stronger penalties for failing to use direct deposit.

By 1995, Social Security Smart Cards will be issued to all people who have a Social Security Number. SSA anticipates that other agencies will want to make use of the card for posting items such as environmental exposures, federal service, food stamp payments, AFDC benefits, driving records, and so on. The technology is available to provide such services. There are, however, a number of concerns from civil liberties, ethnic, and other groups about possible unauthorized uses of such cards.

Auditing and Monitoring

Efficiency will continue to be a key concern at SSA, especially if new responsibilities are added. Because of more and better automation, the overall administrative costs will remain stable at $0.01 for every benefit dollar despite increased workloads. Overpayments will continue to decline. Projected rates for 1995 are:[43]

- OASI - $1 for every $1,000 in benefits
- SSI - $3 for every $1,000 in benefits
- AFDC - $10 for every $1,000 in benefits

In the area of disability, fewer than 5% of SSA determinations will be overturned by the courts. These continued improvements will come from increased automation at the state levels and from increased matching using more automated files from different federal and state agencies. Potential restrictions on matching as a result of several pending lawsuits could hinder SSA's ability to improve its accuracy.

Coordination

All the proposed additions to SSA's responsibilities will involve extensive coordination with other federal agencies from the Department of Agriculture to the Office of Personnel Management to the Selective Service System to the Department of Defense. At the same time SSA will become a central point of coordination with state governments in the provision of welfare and social security services. This will even further increase SSA's assistance to the states in introducing new information systems for welfare administration. One proposal calls for SSA to start charging a fee to those states who are reluctant to adopt modern information technologies.

On the international side, the demand for SSA consultation and products will continue to expand as more countries face difficulties in managing and financing their security and welfare systems. Some countries have considered using SSA as an auditor for their systems. This would involve providing SSA access to all relevant data so it could make the necessary quality assurance checks. The whole process could be handled through international satellite data links. There are understandably a number of concerns in these countries over giving the U.S. government a key to their data systems.

Planning

Planning will continue to improve as more people take a more active role in it. By 1995 OMB, the White House, Congress, interested public and private groups, and SSA line offices will have access to the same data, models, and simulation programs SSA planners use to make projections of the future of the system. This will improve the tenor and quality of social security planning within SSA and in the Congress and the Administration. One possible outcome is a growing recognition of the need for continuing large investments in information technology to support SSA operations.

The deliberations of the Task Force on Disability in the Information Society will highlight the new issues facing disability determinations. For example, concerns over the effects of VDTs on health loom large in future disability hearings, as do the health effects of indoor air pollution.

Personnel

The changes in personnel between the present and 1995 will not be as dramatic as those between 1985 and 1991. For example:

- The number of full time personnel will stabilize at 60,000;
- The use of part time and temporary workers will decline as more teleservice centers are automated;
- More people will work at home, at least part of the time, using the portable computers and SSADARS. This will force a change in supervisory procedures and employee evaluations;
- The health effects of VDTs will be a key issue in labor negotiations at SSA.
- 95% of the staff will have had some computer based training.[44]

Support Services

All paper claims forms, letters, and other documents are stored by SSA and the National Archives and Records Service (NARS). Both are running out of space. Proposals to eliminate paper storage run into issues of the admissability of electronic records in legal proceedings. To deal with this issue SSA and NARS have initiated an interagency Working Group to explore the legal status of electronic documents. The report of the working group will be used by the Justice Department to promulgate government-wide policy on paper and electronic storage.

More people will use videoconferencing to substitute for travel. Many functions such as training and workshops which involved travel can now be handled using electronic mail and computer based training. On the security side, voice recognition technology will be used to identify authorized computer and file users.

SECURITY, PRIVACY, AND PUBLIC INFORMATION IMPLICATIONS

The information technology changes since 1985 and the changes proposed for 1995 will significantly improve the ability of SSA to get the right check in the right amount to the right person at the right time. They will also make it easier for SSA to manage a greater diversity of needs and situations within its beneficiary pool. In addition to improving accuracy, timeliness, and equity of SSA operations, these technological changes will alter the way SSA relates to the public. They will affect the security of SSA operations, privacy, and the provision of public information. Many of these implications have already been noted; they are summarized here.

Security

Security has been a troublesome issue for SSA since the early 1980s. The General Accounting Office recommended that SSA needed to take significant steps to improve the physical and electronic security of its records.[45] SSA has taken those steps. Sensitive computer operations were consolidated in the more secure National Computer Center. Authorization codes were changed more frequently; audit trails were built into the system. In the field offices, security became a more important activity and additional physical and electronic barriers were installed. The move to Social Security Smart Cards was essentially a move to improve the security and integrity of the Social Security Number system by making it much more difficult to produce counterfeit numbers.

Despite these improvements, problems remain. For the past four years a group of employees in one of the Program Service Centers has been operating an elaborate scam.[46] They have been changing death records to address change records so that relatives of deceased beneficiaries continued to receive benefit checks. Once the checks reached a total of $10,000 one of the group would contact the deceased beneficiaries' relatives, identify themselves as Social Security agents, and demand the money back. By using the computer matching capabilities available to SSA employees, the group was able to target their efforts on families who needed the money and would have a hard time repaying it. If families volunteered to return the money, the group collected the money, kept it and changed the address change back to a death notice. If the families said they would have a difficult time repaying the money, the group would offer to forget the whole thing for 20% of the past benefits and 40% of all future benefits. The group was discovered as a result of some computer matching of audit trails by the Project GOGOL task force. By the time they were caught, the Kickback Scam group had more than 1,000 families in their network and were collecting $2 million a year. SSA has recently installed voice recognition devices on all terminals.

In another case, a local medical supplies direct mail house tapped into the Disability Network in several states. From privileged SSA information this firm was able to compile a list of people, addresses, and disabilities for use in their door to door selling. A similar problem occurred in some remote areas in the western U.S. where several teenagers built devices to tap the transmission of data from portable terminals used in branch stations.

Privacy

In the early 1980s personal data was largely unprotected in the SSA system.[47] While SSA has improved physical and electronic security of data, there have been continued concerns with unauthorized use of information, matching, and identity cards. SSA depends on the cooperation of citizens; it cannot rely solely on employers for all the information it needs. People volunteer extensive personal information to SSA -- addresses, family arrangements, medical histories, work histories, earnings histories. These data could be valuable to many different people from lawyers to debt collectors to mail order houses. SSA has a strict policy that it will not share this information with any private groups — only with public agencies which share their data with SSA. Unfortunately, SSA cannot completely control the security of this information and how it is used by state and local governments. SSA's direct mail campaign in support of the Senior Registration Program raised people's awareness that SSA had data on them.

The number of Privacy Act requests on individual files rose dramatically in recent years as more people wanted to determine the type of data SSA had on them. Another source of the increase in requests was a growing concern with errors in SSA data. With the introduction of Social Security Smart Cards, the problem has been somewhat alleviated. However, many errors remain from the 1960s and 1970s — errors which are increasingly coming to light as more people who were working in those years apply for benefits.

Matching has increased significantly since the early 1980s. SSA use of other state, local, and federal agencies data has grown as the search for overpayments has intensified. State and local use of SSA data has also increased as their information collection and analysis capabilities have improved — partly as a result of SSA support and funding. In the last two years several lawsuits have been brought against SSA for participating in computer matching with the states.[48] One lawsuit is a class action on behalf of AFDC recipients who charge that increased matching is an undue invasion of privacy. Another lawsuit involves several doctors who were erroneously put on the SSA list of doctors convicted of disability fraud. Since this list is available to other federal, state, and local agencies they claim their practices have been irreparably and irretrievably damaged.

When the Social Security Smart Cards were introduced, they were seen as a valuable tool for citizens to use in checking government's records on them. However, in the last year, civil liberties and other groups have begun to see vigorously denounce these cards as leading to a national identity card system. Proposals to consolidate many service and welfare functions under SSA and to use the card for similar purposes with other agencies have heightened these concerns.

To allay these fears and the growing concerns over matching and unauthorized use of SSA data, SSA will establish a Public-Private Task Force on Privacy and Data Integrity by June of 1991. This task force will review all requests for matching data, all proposals for non-benefit related uses of data by SSA, and changes in the use of SSSCs.

Provision of Public Information

More information about more aspects of Social Security is available to more people than ever before. Since SSA depends on the cooperation of workers and beneficiaries, it has taken great pains to make itself known and accessible to the widest possible audience. From TV spots to radio call-in shows to electronic bulletin boards to automated teleservice centers to the 63 languages used at the National Information Center to the millions of publications put out every year, SSA clearly puts a lot of emphasis on public information.

On a more specialized level, SSA planning is involves more groups than ever before. Individuals and groups have access to the same data that SSA planners use to forecast the future of the Social Security system including the trust funds. This access has made SSA planning more responsive and more realistic and has reduced some of the conflict surrounding SSA.

SSA continues to impede individuals seeking data on themselves or on others. This restriction has become a bone of contention. In addition to those who want to know what SSA has on them, several people are suing SSA for internal documents relating to their disability determinations — especially the results of the DISQUE process. If the court finds in favor of the plaintiffs in these cases, the future of the disability process could be threatened.

CONCLUSION

With the introduction of new hardware, software, communications systems, and data base management systems SSA has regained its position as a leader in government use of information technologies. The accuracy, timeliness, and equity of traditional SSA responsibilities has steadily improved. As a result SSA has taken on more responsibilities and performed them in an efficient and effective manner. However with these new responsibilities have come new issues including:

- Improving electronic security
- Keeping up with changing information technology
- Controlling unauthorized use of SSA information
- Managing the use of Social Security Smart Cards
- Keeping up with changes in the economy and population
- Moving from paper storage to electronic storage

These issues are essentially second order corrections. The first order correction — bringing SSA from survival to the state of the art — has been accomplished.

Exhibit 18

INFORMATION TECHNOLOGY AT SSA

1985, 1991, 1995

CATEGORY	1985	1991	1995	KEY FORCES
MISSION	OASDI benefits when workers retire, are disabled, or die; SSI to the blind, aged, and disabled; oversee AFDC; pay over $200 billion to 50 million people.	Largely the same as 1985; two additions - two tier benefit system and Seniors Registration Program. Both depend in information technology.	Additional responsibilities including Unified Federal Pension System, Food Stamps, Draft Registration. Possible comparable worth corrections.	Pressure to consolidate government functions and reduce overlap. Continued need for social security.
Info. Collection and Analysis	Field offices are primary contact - being modernized; 34 teleservice centers; increase MIPS from 14 to 45; programmers manage 22,000 lines of instructions; 1/2 files on-line.	Modernization completed; terminals for every 2 claims reps.; expert systems APPLIQUE, DISQUE, COMPASS in use; increased workload for SSADARS and NCC; reduced manual tape handling.	One terminal for every claims rep.; all state DDSs automated; expanded SSADARS and increased workload for NCC; all data on line; emerging data decay issue.	Improved technology; management commitment to keeping up with change; growth in the size and sophistication of benefit population; pressures on financial integrity of trust funds.
Information Dissemination	100 million copies of 50 publications; 40 million inquiries - 21 million by phone. TV and radio spots in English and Spanish.	Electronic bulletin boards in 43% of field offices; 73% of inquiries by phone - a third handled by automated teleservice centers.	60 million inquiries - 90% by phone; 60% automated teleservice. Elec. bulletin boards in all DOs; portable terminals - contact stations.	Active, educated, healthy constituencies pressing for their benefits; growing use of information technology in society in general.
Disbursement	Checks from FMS; 40% direct deposit; social security cards on banknote paper	Checks from FMS; 65% direct deposit; Social Security Smart Cards (SSSCs) and earnings meters introduced.	Right check to right person at right time 100%; 80% direct deposit; expanded use of SSSCs.	Pressure to get checks to people as fast as possible; demand for citizens control of information on them.
Audit/Monitor	Overpayment key concern; OASI = $4.51/$1000; SSI = $36/$1000; AFDC = $73/$1000 Computer matching used; 34% disability det. overturned.	Continued attack on overpayment using info. tech; OASI = $2.23/$1000; SSI = $10.43/$1000; AFDC = $24/$1000; 10% det. overturned.	Low administrative costs; declining overpayments; OASI=$1/$1000; SSI=$3/$1000; AFDC=$10/$1000; 5% disability determinations overturned.	Financial pressures resulting from more beneficiaries and fewer workers; capabilities for matching improve.
Coordination	Oversee and share with many state agencies; extensive international consulations and agreements	Closer ties with states as automation increases. Translation of expert systems programs.	Fees for agencies not upgrading information sytsems; more auditing/monitoring foreign systems.	Fiscal pressures on the states; growing use of IT in foreign and state governments.
Planning	Rocked by continual turnover and reorganizations; projections seen as overly optimistic.	Improved data, simulations, models, and participation; better management info.; more people demand access.	Interest groups on line to SSA data, models, and projections; new definition of disability emerges.	Sophisticated active constituencies want more information; more software for doing projections.
Personnel	74,145 full time; 15,000 workyears from part-time; 8,000 in information systems; problem: losing programmers.	17,000 fewer full time; more part time due to automation; able to attract good programmers; 70% CBT.	60,000 full time; fewer part time with more automation; health and VDT's an issue; 95% CBT.	Automation of many operations; need to reduce federal deficit; search for economies; continued power of unions.
Support	Move to the New Computer Center (NCC); overloaded automated supply system.	Automated supply handling using smart cards; more electronic security measures and dispersal of operations.	Paper storage a growing issue; more video and computer conferecing to substitute for travel.	Need to control inventories to reduce costs; growing concerns over privacy.
IMPLICATIONS				
Security	Physical security dominates; security seen as a key problem at SSA.	Improved security; disperse facilities; kickback scam forces use of encrypted communications.	Voice recognition added to all terminals; improved electronic countermeasures;	Growing value of SSA info.; improved tapping and countermeasure technology; increased terrorism and vandalism.
Privacy	Matching used especially by states in locating AFDC overpayments. Personal records unprotected.	Increased FOI requests; More matching - eg GOSOL; matching lawsuits threaten system.	Growing concern over use of SSSC as a national identity card; continued debate over matching despite task force.	Pressures for efficiency in government operations to reduce deficits.
Public Information	Millions of documents; extensive public information campaigns; assistance in Spanish available where needed.	National Information Center has 63 languages; many ways for citizens to get information on benefits, programs or SSA.	Largely electronic communication with the public; access to many SSA planning documents; conflict over access to sensitive info.	Active, interested, increasing beneficiary public; spread of home computers and user friendly software.

REFERENCES

1. See Aime Francois, The Application of Information Processing in Public Administration, (Brussels: International Institute of Administrative Sciences, 1973)

2. See Office of Systems, Social Security Administration, Systems Modernization Plan (SMP): From Survival to State of the Art, (Baltimore: SSA, February 1982), section 1.2 especially.

3. The awards dinner and the roundtable are fictitious. Some of the comments are based on the workshop with personnel at SSA.

4. See SMP, section 2.5.

5. These are taken from SSA, "Report on Activities and Achievements Fiscal Year 1984," pullout from Oasis (November 1984).

6. Dr. Kenneth Hammond of Colorado University is a noted researcher on judgment and decision making; the name of the theory is fictitious but the body of knowledge is not.

7. This project -- the search for dead souls -- is an extrapolation of the activities described in SSA, 1984 Annual Report to the Congress, (Baltimore: SSA, 1984).

8. This is a logical extrapolation of existing smart card technology applied to the problems of creating tamper-proof Social Security Cards.

9. See SMP, section 1.2

10. See SMP, section 2.2

11. FEDNET is fictitious though not implausible given the spread of cable TV, demands for government information, and the success of C-SPAN.

12. This is a reasonable extrapolation from the data provided in the 1984 Annual Report.

13. This program is fictitious but has a parallel in the Draft Registration Program.

14. See Paul Light, Artful Work: Politics of Social Security Reform (NY: Random House, 1985), chapter 4.

15. See SMP, first page.

16. See Oasis (1/84)

REFERENCES (continued)

17. See SMP, figure 2.6.

18. See SMP, section 2.5.

19. See 1984 Annual Report.

20. See SMP, figure 2.5.

21. See 1984 Annual Report, p. 25

22. See 1984 Annual Report, especially pp. 18-20.

23. This legislation is fictitious and intended to illustrate the expanded capacities of SSA information systems.

24. See Oasis (1/85).

25. These programs are fictitious but within the reach of expert systems technology.

26. This is a reasonable extrapolation from the current experiment.

27. This network is fictitious but within the capabilities noted in the SSA section of OMB, GSA, Commerce, Five Year Plan for Meeting the Automatic Data Processing and Telecommunications Needs of the Federal Government, Volume 2 (April 1984).

28. This projection is based on footnote 17.

29. Time for posting is estimated at 7 months in 1989; this is a reasonable extrapolation from that estimate.

30. This is a reasonable projection based on anticipated improvements in software testing and programmer productivity.

31. This projection is based on footnote 20.

32. These bulletin boards do not exist now in SSA; they are used by other agencies such as NBS.

33. This Center is a fictitious illustration of an information technology response to a social need.

34. This is a reasonable extrapolation from the current level of 40% given the circumstances described.

REFERENCES (continued)

35. These estimates are in line with the improved capabilities of information technologies at SSA.

36. The commission is fictitious; it is used to illustrate a possible avenue of public discontent with the disability process.

37. This increase in return on investment in collection results from better auditing and better collection procedures.

38. The Reagan Administration has proposed cutting 17,000 people from SSA in the next 6 years as a result of automation. See "Cuts at Benefits Agency Seen" New York Times (2/1/85).

39. This unified system is fictitious but could come to pass as the Administration seeks to control federal outlays in attempting to reduce the deficit.

40. This projection is based on footnote 17.

41. This projection is based on footnote 20.

42. This projection is based on footnote 34.

43. This projection is based on bootnote 35.

44. This estimate came out of the workshop with SSA personnel.

45. Arnold Levine, "GAO Investigation Faults SSA Paradyne Contract". Government Computer News (September 1984).

46. This scam is a fictitious illustration of what could occur to increase attention to security.

47. See SMP p1-15.

48. These fictitious lawsuits illustrate the kinds of privacy issues that may arise.

CHAPTER VII

PLANNING FOR FEDERAL INFORMATION TECHNOLOGY: CONTINUITY AND CONFLICT

Introduction

Planning for information technology is newly prominent in the federal government. The Federal Paperwork Reduction Act of 1980 and subsequent OMB and GSA pronouncements promoted this type of planning. Information technology costs more and is more important to most agencies. Older information systems are being upgraded and replaced. As a result, information resources management and the planning that accompanies it have become a turbulent area of government operations.

As more agency administrators, OMB budget examiners, and Congressional staffs turn their attention to telematics planning, the conflicts among goals, strategies, and objectives of information resources management (IRM) sharpen. What goals should take precedence in agency IRM plans — efficiency, responsiveness, effectiveness, developing new missions, survival?* Whose view of the future should guide the plans — that of the agency IRM office, agency management, GSA, OMB, Congress, vendors? Can agency plans be flexible and strategic when procurement is rigid and shortsighted? What role should the central agencies such as OMB and GSA play vis a vis the agencies? How much autonomy should individual departments have in creating IRM plans?

Federal government use of information technology is only as good as the planning that supports it. Good planning depends on realistic demands, consensus on goals, and encouragement from oversight bodies such as Congress, GAO, OMB, and GSA. To enhance information technology management, these oversight bodies need to understand the dynamics of telematics planning, the tensions inherent in it, and the opportunities for improvement.

This chapter provides the basis for such understanding. Most discussions of information technology planning cover the formal processes, requirements, or outputs. This chapter takes a different approach. Using experience in general long-range planning, federal government strategic planning, and research on the information technology plans of five different federal agencies, this chapter outlines how government agencies plan for information technology. It discusses the general characteristics of information technology planning, and specific agency styles of telematics planning.

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* The term, agency, is used broadly in this report. It encompasses not only Cabinet departments and independent agencies but also the bureaus, services, administrations, and agencies that comprise those organizations.

Information technology planning is a special case of government planning. The first section of the chapter makes several observations on the nature of government long-range planning to give some perspective on this special case. The next section discusses telematics planning — where it coincides and where it differs from more general planning. The third section outlines the range of agency styles of information technology planning. The following chapter identifies fundamental tradeoffs in telematics planning, reviews areas in need of improvement, and suggests possible Congressional actions.

Observations on Planning in Government

Information technology planning is part of the more general phenomenon of planning in government. All agencies plan. At the most routine levels they anticipate their needs for people, resources, facilities, equipment, supplies — usually as part of the annual budget preparation and review. At a higher level, agencies look for new missions, ways of meeting old missions, new constituencies, and ways of maintaining established constituencies. Whether it involves routine budget planning, information technology planning, or redirection of the agency, government planning has several common features. This section reviews these features to provide background on information technology planning.

Long-range planning in government has improved steadily over the past decade. Foresight has become a more important element of government policymaking as documented by the Council on Environmental Quality's 1984 paper on foresight, the NSF inventory of foresignt activities in government and the private sector, the Global 2000 study, and the Commission on a National Agenda for the Eighties.

Most of the difficult and creative work of converting foresight into plans is going on in the government agencies from the Forest Service to the Financial Management Service, from the Corps of Engineers to the Environmental Protection Agency, from the National Oceanic and Atmospheric Administration to the Department of Defense. In these agencies, planners are looking at the forces shaping their future and creating strategies for making the most out of the future. These plans form the basis for more detailed budget, facilities, equipment, procurement, and personnel planning.

A Generic Agency Planning Process

All agencies share several basic components of planning. For the most part, they reflect general planning principles and the difficulties of doing long-range planning within the federal government. Agencies plan in several basic steps:

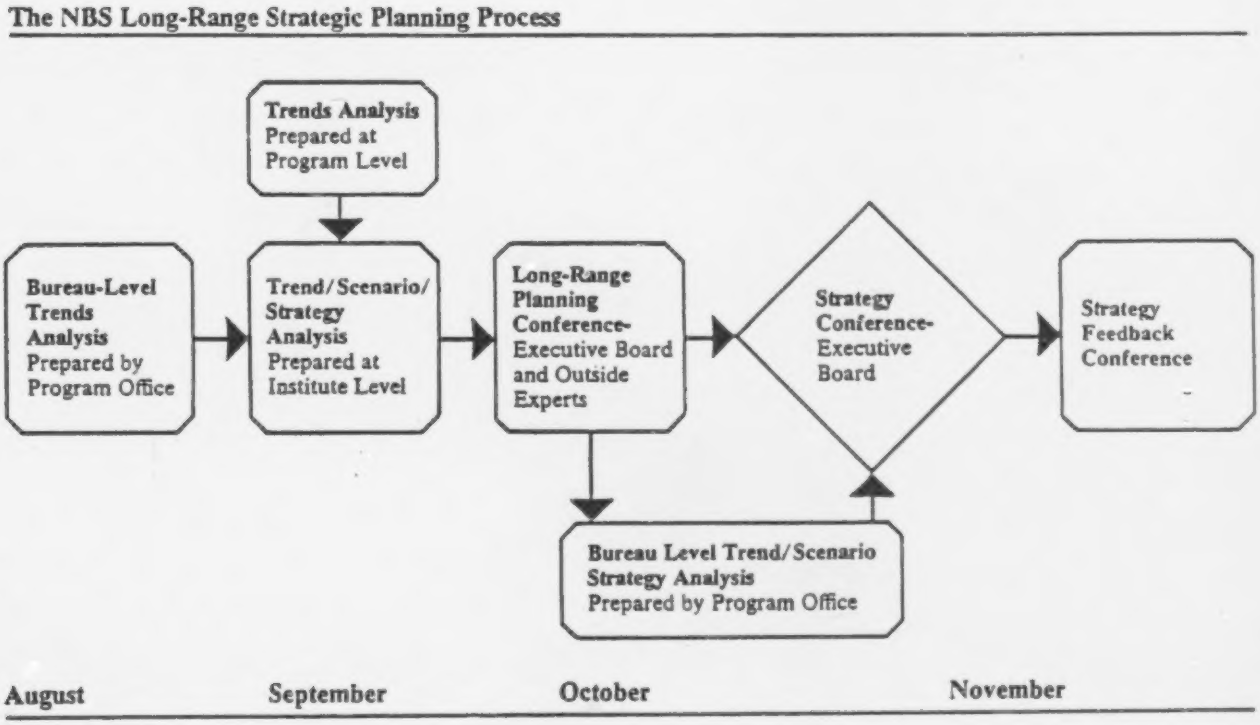
- Create planning structure -- existing office, special task force, ad hoc senior managers committee, etc.
- Delegate operational planning authority
- Clarify mission
- Identify goals or objectives of the agency
- Examine the external environment — trends in government, demands on the agency
- Set planning priorities, both federal and agency
- Collate and coordinate operational plans
- Bring the plan into line with the budget process
- Iteration, feedback, and evaluation

One common approach is illustrated by Exhibit 19. Note that the process described in the exhibit follows an annual cycle. This is common in most agencies and is often synchronized with the annual budget cycle.

While the scope, timing, direction, and subjects of ageny plans vary among agencies, there are several commonalities among these efforts (see Exhibit 20). These common characteristics include:

Exhibit 19

A COMMON AGENCY PLANNING PROCESS**


The NBS Long-Range Strategic Planning Process
Trends Analysis Prepared at Program Level
Bureau-Level Trends Analysis Prepared by Program Office
Trend/Scenario/ Strategy Analysis Prepared at Institute Level
Long-Range Planning Conference-Executive Board and Outside Experts
Strategy Conference-Executive Board
Strategy Feedback Conference
Bureau Level Trend/Scenario Strategy Analysis Prepared by Program Office
August
September
October
November

** National Bureau of Standards planning process as described in Michael H. Moskow, Strategic Planning in Business and Government, (NY: Committee for Economic Development, 1978).

Exhibit 20

CHARACTERISTICS OF PLANNING IN GOVERNMENT

- Agency based
- Diverse methods
- Incremental
- Goals difficult to define
- Short time horizon
- Top level turnover
- Separation of planning and implementation
- Strong external influences
- Hard to tie planning to decisionmaking

- Agency based: Planning in government is an agency or department level activity. In some cases such as Treasury, the individual services such as the Internal Revenue Service and the Financial Managment Service do the majority of the planning. In other agencies such as NOAA, the plans of the National Weather Service dominate the agency's approach. In an agency such as EPA, headquarters plans for the entire agency.
- Diverse methods: The methods of planning are as varied as agencies that plan. Some use top down planning where the basic directions come from the top management and the specific strategies and tactics are worked out by middle and line managers. In other agencies, a bottom up approach seeks ideas from all staff on directions for the agency. These ideas lead to subunit plans which are used to create an overall agency plan. Some agencies use other agencies or private firms in planning; others use only internal resources. Some plans are made public; other agencies keep plans confidential. The form of planning in an agency depends on the style of the top management, the history and tradition of planning in the agency, and the demands on the agency from other agencies and the public.
- Incremental: Planning in any large organization with a stable mission and workforce tends to be incremental. The emphasis is on the marginal changes that can make the agency better able to meet its current mission and in a good position to take on related new missions. The focus is on improving efficiency and effectiveness while ensuring trouble free survival and growth.
- Goals difficult to define: Agencies have a difficult time setting specific goals toward which plans should aim. Where corporations have explicit measurable goals — profit, stability, growth — government agencies generally have broad, ill defined, often conflicting missions. For example the mission of the U.S. Department of Agriculture is to

promote efficient and large scale farming (agribusiness) and to protect the family farm. Social Security Administration and the U.S. Postal Service look for ways to give maximum service at minimum cost while serving the needs of all their legislatively mandated clients. When agencies try to specify goals they court trouble. An explicit statement of a goal which will drive action calls attention to conflicts among goals in competition for resources. This invites attacks from Congress, interest groups, or OMB.

- Short time horizon: Government long-range planning looks ahead three to five years. Planning for ten years ahead is pure speculation. Several forces work against long-term planning in government: leadership change, planning attention on the annual budget cycle and marginal change, a lack of explicit long-term goals, and the relative newness and ragged pattern of strategic planning in government.
- Top level turnover: For it to work, top level management must be committed to planning. Commitment is difficult to maintain when the leadership of agencies turns over every 18 to 24 months. Also, the head of an agency has limited control in the selection of his or her management team; at EPA, 13 top managers are approved by Congress. Commitment to the agency head or familiarity with the agency and its long-term needs is rarely a dominant factor in the selection of top managers by Congress.
- Separation of planning and implementation: Plans do not work unless they are backed up by money, people, time, and other resources. Most federal agencies do not have the power to increase or decrease their personnel, budget, equipment, or facilities allocations. These decisions are made by Congress, OMB, the White House, and, in the case of subunits such as NOAA, parent organizations such as the Department of Commerce. The common agency strategy is to make incremental, short-term changes which do not require outside approval.

- Strong external influences: Federal agencies have many bosses — Congress, the White House, OMB, powerful constituent groups, and parent or related agencies. Agencies are too visible and too open to influence to plan and implement significant change. Change requires extensive consensus and therefore is slow to come and difficult to control. For example, the rise of public concern with toxic wastes led to Congressional action which resulted in the Superfund program directed by EPA. Pressure from the Administration has driven IRS to become more active in seeking those who default on student loans.
- Hard to tie planning to decisionmaking: The life of a federal agency head is a cross between a firefighter and the King of Spain. In one role, the director is constantly responding to the crisis of the moment often generated by Congress, constituents, or the White House. In the other role, he or she is chairing blue ribbon panels, meeting with dignitaries, giving testimony, or speaking to constituents. The tendency to focus on the immediate or the superficial drives out close attention to the relationship between current activities and agency long-range plans and strategies.

These characteristics of planning in government set the stage for understanding telematics planning. The next section discusses the convergence and divergence of information technology with this general pattern of planning in government.

Information Technology Planning in Government

Planning for information technology is a recent development in the federal government. Its growth has followed the increased use of computers, telecommunications, and other technologies to collect, analyze, store, and transmit government data. Speicfically, the interest in information technology has increased with:

- more widespread applications of the technology in government
- the dependence of many government functions on the technology
- rising costs for software and hardware

- increased difficulty in attracting needed personnel
- rapid technological change
- declining federal leadership in information technology use

These changes were embodied by the changing legislation dealing with government use of information technology. By the late 1950s information technologies, especially the computer, were starting to be seen as practical tools for business and government. By the late 1960s, these technologies had become integral to the functioning of many agencies including the Department of Defense, the Weather Service, Treasury, Social Security Administration, and others. Computers went first to those agencies with large volume routine tasks such as tax collection and benefits payment.

During the early 1960s the only legislative guidance to information technology management came from the Federal Reports Act of 1942; the Act concentrated more on government reporting forms than on managing federal information resources. The Brooks Act enacted in 1965 amended the 1942 Act by assigning central management responsibility to the Bureau of the Budget (now OMB), GSA, and the National Bureau of Standards. Bureau of the Budget would set overall fiscal policy; GSA would set procurement policy; and NBS would provide technical standards and consultation. The goal was a centralized, efficient, and flexible management system for information technology. The Brooks Act did not give extensive attention to planning except as an adjunct to policy setting.

By the mid 1970s it was clear the Brooks Act was not working. OMB was not giving overall policy guidance. GSA was delegating responsibility without providing guidance. NBS was slow in taking the initiative in developing standards. A series of commissions on privacy, procurement, and paperwork grew out of the growing mismatch between the importance of information technology to government and the primitive state of information technology management in government. The results of these commissions led to the Federal Paperwork Reduction Act of 1980 -- a key document in the history of information technology planning in the federal government.

The Federal Paperwork Reduction Act gave OMB the authority to set government wide policy for information management. It also reaffirmed the GSA role in acquisition policy. Most important, it affirmed the need for integrated approaches to information resources management (IRM). The mechanism for ensuring effective management of information technology was oversight of agency information technology plans. As the assistant director of OMB, Joseph Wright, said,"The fat, easy days for big agencies to come in and get an upgrade are over. [They will not be able to] bury ADP acquisitions in another budget item such as food stamps."(1) Implementation of the 1980 Act has therefore led to an explosion in agency information technology planning and guidance for that planning.

The generic process of information technology planning is quite similar to that of general planning. The GSA IRM Review handbook suggests the following steps:(2)

- Update agency-wide inventories of information resources.
- Define the missions, broad objectives and policies of the IRM organization.
- Develop approaches for achieving agency missions and broad IRM objectives within the context of existing policies.
- Prepare specific top down planning directions (call for plans).
- Develop, consolidate and approve detailed plans and budgets.
- Prepare supplemental analyses.
- Prepare progress reports based on performance against the plans.

Information technology planning, like general planning, is often done annually and in time to feed into budget preparation.

While information technology planning is relatively new in the federal government, it is already exhibiting many of the qualities characteristic of general planning in government:

- Agency Based: Agencies do the planning for telematics. Directives and guidance from OMB and GSA recognize that the specific mission and program requirements of the individual agencies drive the process and substance of the agency information technology plans. Central agency guidance is there to assist those agencies that need help and to provide a framework for making comparisons among agencies. There are a number of government-wide directions which OMB is promoting, such as avoiding information monopolies within agencies, sharing information resources among agencies, and avoiding interim upgrades.(3) These are to be incorporated into individual agency plans.

- o Diverse methods: Agencies information technology planning processes differ as much as other planning processes. Agencies with large central data processing responsiblities often use a top down approach while agencies with dispersed, varied, and fragmented uses often use bottom up planning. While GSA's IRM Review Handbook offers some general guidelines on how to plan, it also recognizes that each agency must develop its own way.

  The newly established Federal Information Resources Management Planning Support Program (FPSP) in GSA is an in-house government consultant on methods for information technology planning. It offers services to agencies ranging from reviewing plans to conducting the planning process. Their approach centers around tailoring the process to each agency.(4)

- o Incremental: The experiences of the past decade have taught information resource managers to plan improvements cheaply and incrementally. Large system wide improvements are immediate targets for OMB and Congressional staff. To avoid these attacks many IRM managers chose to make do with existing resources or to ask for only incremental upgrades. The result is obsolescence in federal information technology as noted in the report of the President's Private Sector Survey on Cost Control (the grace Commission).(5) In the Social Security Administration this obsolescence created a crisis in the agency's ability to fulfill its missions.
- o Short time horizon: Given the incremental nature of much

federal information technology planning it is not surprising that many plans have short time frames. GSA implicitly recognizes this when it calls strategic information technology planning anything beyond one year. The current outside horizon for information technology plans required by OMB and GSA is five years.

- Top level turnover: Top management commitment to information technology planning is essential to its successful implementation. At FAA, top level commitment made the work of the FPSP more productive and effective. At SSA, the frequent turnover in management was cited as a major source of the agency's information technology management problems. The current planning structure involving the appointment of senior IRM officials in each agency is an attempt to get around the constant turnover; however most of these are appointed officials. The top level steering committees GSA recommends to assure top level commitment are at best conservative and at worst ineffective. One of the central problems is that senior agency managers have little knowledge or appreciation of the implications of information technologies for the agency. Many view it as another housekeeping function like supplies, equipment, or facilities.
- Separation of planning from implementation: Implementation of information technology the plan rarely lies in the hands of the agency. The requests must pass through the hurdles of agency review, OMB, and the authorizing and appropriating committees in the Congress. This formidable course deters all but the most resolute or the most desperate. Even if an agency succeeds in getting over these hurdles, labyrinthine procurement and hiring practices make it difficult for agencies to respond rapidly to their changing needs.

Information technology planning, like government planning in general, is done by agencies, in idiosyncratic fashion, focusing on the short-term incremental changes in its control. However, the technology has several characteristics that make it different from most other subjects of government planning. Specifically:

- Networks which create interdependencies
- Power to centralize and decentralize agency functions
- Power to obscure and reveal data about people and institutions
- Subversion of hierarchical chains of command
- Integration of previously separate functions
- Effects on virtually every agency function(6)

These characteristics lead to the special features of information technology planning listed in Exhibit 21. These features include:

- Legislative framework: Most planning in government is done at the discretion of the individual agency. The Federal Paperwork Reduction Act of 1980 requires agencies to prepare five year plans on information technology. The Act also gives OMB and GSA substantial roles in guiding information technology planning. This makes information technology planning more formal, proceduralized, bureaucratic, and visible than other types of agency planning.
- Close ties to other agency functions: All agencies are affected by information technology at least at the level of office automation. Many agencies depend on these technologies to fulfill their missions whether it is predicting the weather, clearing checks, or collecting demographic data. While information technology is important to all agenices, it is a tool. Like human resources planning, telematics planning is subordinate to the mission and program goals of the agency. However, the future wealth or dearth of information technology can make or break an agency's ability to meet its missions or to take on new missions. But, information technology plans cannot help an agency without backing from human resources plans and procurement plans. If the agency cannot get the equipment and people it needs when it needs them, information technology plans are of little use.

Exhibit 21

SPECIAL FEATURES OF INFORMATION TECHNOLOGY PLANNING

- Legislative framework
- Close ties to other agency functions
- Affects all employees
- High costs of information technology
- High uncertainty about technological changes
- Pressure to keep up with the private sector
- Crisis mentality
- Importance of integration
- Lack of vision

- Affects all employees: Information technology affects the way every federal employee does his or her job. In addition, 120,000 federal employees program and manage the government's 20,000 mainframe computers.(7) Changes in the technology can create new jobs, abolish old ones, change other jobs, and significantly alter the career paths of many employees.
- High costs of information technology: Despite declining per unit hardware costs, information technologies are becoming a bigger part of agencies' budgets. Fiscal year 1986 agency requests for information technology were $14 billion, making the federal government the biggest user of information technology in the world.(8) As they become bigger budget items, these systems are more visible to people within the agency and in oversight bodies such as GAO, OMB, and the Congress. This new prominence moves technology planning from routine equipment planning to a more critical and more specialized type of planning.
- High uncertainty about technological change: Dependence on innovation in many scientific disciplines from mathematics to materials, rapid changes in the types and capabilities of information technologies, declining hardware costs and rising software costs, and an uncertain labor supply generate substantial uncertainty for telematics planning. Seeking certainty, planners look for reliable forecasts of future technologies. To meet this need NBS published forecasts of information technologies in 1981 and 1983. However, agencies also turn to vendors and other experts for forecasts. Here agencies run into the problem of separating the facts from the hype that infests the industry. Differences in forecasts make information technology plans difficult to develop, review, evaluate, and implement.
- Pressure to keep up with the private sector: The public sector once set the pace in information technology use. In recent years the private sector has found information

technology essential to its needs to produce reports, manage buildings, fly aircraft, make automobiles, farm the land, or provide health care. The needs of the private sector dominate the information technology marketplace. Commercial uses of hardware and software are years ahead of government use of the technology. The goal of the FY 1986 OMB management guide is to recapture government's position as a leader in the efficient and effective use of information technology.(9) However, government is quite different from the private sector; it is much larger, more diverse, subject to more top level management turnover than the private sector. Also it has many unique data processing needs from guiding missiles to posting wages on Social Security records to tracking polluters. Yet, the pressure from Congress, OMB, and the public to become as efficient, cost effective, and modern as the private sector continues to grow unabated.

- Crisis mentality: In the last five years many agencies have faced a self-described "crisis" in its information technology. The dismal state of SSA computing in the early 1980s, the obsolete systems at the Financial Management Service, the declining capacity of EPA mainframes are examples of the crises suffusing information technology planning. Top level turnover, incremental approaches, high costs, and new tasks imposed from outside created these crises. Since these forces will not disappear, information technology plans will continue to contain pleas ranging from urgent to desperate.
- Importance of Integration: Integration of information systems across an agency and across government is coming to dominate many information technology plans. Integration includes not only matching telecommunications systems with mainframes with end user computing with word processing with database management but also integrating software and databases within and across agencies. OMB's draft circular on Management of Federal Information Resources is particularly strong on

the need for integration.(10) In practice, integration is only beginning in many agencies. The review of agency plans found that many were collections of individual project plans full of redundancies and incompatibilities.(11) Most agency plans were tactical and short-term with little attention to the overall future of agency information resources management.

- Narrow vision: Information technologies have the potential to transform the way government works -- from the types of people it employs to the way it interacts with citizens. Plans reflect none of the transformational possibilities. They use a substitution model; new information technologies will allow agencies to do what they do faster, more efficiently, and more effectively. This is reflected in the dominant concern with cost containment and management reform. Plans rarely address the new ways they can provide public access to information or the new missions which the technology can support or create. Note the lack of support from Congress, OMB, or GSA for experimental, innovative ways of using information technologies to meet agency goals. One reason for the narrow vision in information technology planning is the tendency to view it throughout the agency -- from top management to clerks — as an exercise done by technicians for technicians.

To summarize, information technology planning is like most other planning in government in that it is largely agency based, incremental, and focused on the short term. Also it suffers from top management turnover and lack of control over implementation. What makes telematics planning different are: a legislative framework, close ties to other agency functions, effects on all employees, high uncertainty, continual crisis and pressure to keep up with the private sector, and narrow vision. In the next section we turn to the manifestation of these general characteristics in specific agency styles of information technology planning.

Agency Information Technology Planning Styles

All agencies use information technology. They differ on how important information technology is to their mission. For example, at the Federal Communications Commission and the Soil Conservation Service information technology is an adjunct to agency or field activities. On the other end of the spectrum, information technology is the lifeblood of the Bureau of the Census and the Social Security Administration; without the technologies, these agencies could not do their jobs.

Information technology (IT) planning reflects differences in the importance of information technology to the mission. At Census and SSA, IT planning is seen as an important activity and is closely tied to overall agency planning. At the Soil Conservation Service and the Federal Communications Commission planning centers on office automation because information technology is seen as a routine tool to improve efficiency.

This section addresses the differences in the ways agencies plan for information technology. These differences tend to show up in seven different features of agency IT planning:

GOAL DRIVEN, LONG TERM ....INCREMENTAL, SHORT TERM

Some agencies take a long term, strategic approach to IT planning - looking for ways to integrate IT into the agency strategic plans. Other agencies look primarily to modest improvements they can make in existing systems that will enable them to do their job better.

CENTRALIZED.............DISTRIBUTED

Agency planning can vary from highly centralized, headquarters based approaches to highly decentralized, localized planning by individual agencies, regional offices, or field offices.

TOP DOWN, HIERARCHICAL.............BOTTOM UP, PARTICIPATORY

Some agencies encourage participation from line offices and interested individuals. Other agencies prefer to have top managers create the framework within which other managers operate. Most agencies use some mix of the two.

STRUCTURED.............INFORMAL, AD HOC

While the requirements of the Federal Paperwork Reduction Act of 1980 and the resulting OMB and GSA guidance have increased the formalism of all agency plans, styles continue to range from highly structured, rigidly scheduled, formal processes to informal assessments of future information technology needs and potential.

INTEGRATED.............FRAGMENTED

Several agencies look at their information technology resources in an integrated, system wide manner. Others take a less coherent more fragmented approach by planning the future of individual technologies, databases, or pieces of hardware.

SECURITY/PRIVACY.............EFFICIENCY/ACCESS

Agencies differ in the degree to which they pay attention to security and privacy issues. Some are concerned primarily with increasing efficiency of operations and providing access to internal and external authorized users. Others take great pains to protect the security of the system and the integrity of data.

FOREFRONT TECHNOLOGY.............ESTABLISHED TECHNOLOGY

Some federal agencies are dependent on leading edge or state of the art technologies such as supercomputers. Others only need established routine technologies such as personal computers or office automation equipment.

We used these features to categorize five agency styles of IT planning; see Exhibit 22. These five styles and the placement of agencies within the different styles are based on our review of agency plans, analyses of information technology planning in government agencies, and our judgment, since plans and planning discussions are rarely explicit about planning styles.

The following discussion elaborates on the five agency styles by describing the IT planning processes of the agencies using that style. The brief descriptions of the agencies show how structure, mission, and information functions of the agency lead it to adopt a particular style.

Exhibit 22

AGENCY STYLES OF INFORMATION TECHNOLOGY PLANNING

1. LONG TERM, DISTRIBUTED, INFORMAL, FRAGMENTED, FOREFRONT TECHNOLOGY

- NOAA
- NASA

GOAL DRIVEN, LONG TERM	....●...............	INCREMENTAL, SHORT TERM
CENTRALIZED	..................●.	DISTRIBUTED
TOP DOWN, HIERARCHICAL	............●.......	BOTTOM UP, PARTICIPATORY
STRUCTURED	..................●.	INFORMAL, AD HOC
INTEGRATED	..................●.	FRAGMENTED
SECURITY/PRIVACY	..........●.........	EFFICIENCY/ACCESS
FOREFRONT TECHNOLOGY	.●..................	ESTABLISHED TECHNOLOGY

2. INCREMENTAL, CENTRALIZED, TOP DOWN, STRUCTURED, INTEGRATED, SECURITY/PRIVACY EMPHASIS, ESTABLISHED TECHNOLOGY

- GSA
- EPA
- ENERGY
- FBI
- NSF
- SSA

GOAL DRIVEN, LONG TERM	..................●.	INCREMENTAL, SHORT TERM
CENTRALIZED	.●..................	DISTRIBUTED
TOP DOWN, HIERARCHICAL	.●..................	BOTTOM UP, PARTICIPATORY
STRUCTURED	.●..................	INFORMAL, AD HOC
INTEGRATED	..●.................	FRAGMENTED
SECURITY/PRIVACY	...............●....	EFFICIENCY/ACCESS
FOREFRONT TECHNOLOGY	...............●....	ESTABLISHED TECHNOLOGY

3. LONG TERM, CENTRALIZED, INTEGRATED, PRIVACY/SECURITY EMPHASIS, FOREFRONT TECHNOLOGY

- IRS
- CENSUS
- FAA

GOAL DRIVEN, LONG TERM	.●..................	INCREMENTAL, SHORT TERM
CENTRALIZED	.●..................	DISTRIBUTED
TOP DOWN, HIERARCHICAL	.........●..........	BOTTOM UP, PARTICIPATORY
STRUCTURED	.........●..........	INFORMAL, AD HOC
INTEGRATED	.●..................	FRAGMENTED
SECURITY/PRIVACY	..●.................	EFFICIENCY/ACCESS
FOREFRONT TECHNOLOGY	.....●..............	ESTABLISHED TECHNOLOGY

--> (cont.)

Exhibit 22 (cont.)

AGENCY STYLES OF INFORMATION TECHNOLOGY PLANNING

4. LONG TERM, CENTRALIZED, PARTICIPATORY, AD HOC, INTEGRATED, EFFICIENCY/ACCESS EMPHASIS, ESTABLISHED TECHNOLOGY

- FCC
- JUSTICE
- CPSC
- STATE

GOAL DRIVEN, LONG TERM	.●..................	INCREMENTAL, SHORT TERM
CENTRALIZED	.●..................	DISTRIBUTED
TOP DOWN, HIERARCHICAL	..............●.....	BOTTOM UP, PARTICIPATORY
STRUCTURED	..................●.	INFORMAL, AD HOC
INTEGRATED	.●..................	FRAGMENTED
SECURITY/PRIVACY	..................●.	EFFICIENCY/ACCESS
FOREFRONT TECHNOLOGY	..................●.	ESTABLISHED TECHNOLOGY

5. INCREMENTAL, CENTRALIZED, BOTTOM UP, INFORMAL, FRAGMENTED, EFFICIENCY/ACCESS EMPHASIS, ESTABLISHED TECHNOLOGY

- USDA
- COMMERCE
- INTERIOR

GOAL DRIVEN, LONG TERM	..................●.	INCREMENTAL, SHORT TERM
CENTRALIZED	..................●.	DISTRIBUTED
TOP DOWN, HIERARCHICAL	...........●........	BOTTOM UP, PARTICIPATORY
STRUCTURED	..................●.	INFORMAL, AD HOC
INTEGRATED	..................●.	FRAGMENTED
SECURITY/PRIVACY	..................●.	EFFICIENCY/ACCESS
FOREFRONT TECHNOLOGY	..................●.	ESTABLISHED TECHNOLOGY

1. LONG TERM, DISTRIBUTED, INFORMAL, FRAGMENTED, FOREFRONT TECHNOLOGY NASA.

NASA is a research and technology-intensive agency with long experience in mission-related IT. However, NASA is not an information-intensive agency. Beyond administrative needs, information handling is secondary, supporting its core R&D mission and space operations. NASA's information priorities are quality, forefront, computing rather than high volume data handling or broad dissemination. Information gathering, processing, and application is narrowly focused. The user community for NASA information is small, technologically sophisticated, and well-informed.

NASA is spread around nation in nine disparate and autonomous centers, each with different cultures and goals. Management, procurement, and personnel are decentralized. NASA's planning style is distributed and relatively unstructured, fitting its decentralized organization.

NASA decided, after much study, to use an informal, unstructured IT planning style to fit its organization and culture. The result, the Automated Information Management (AIM) Council, develops policy and guidelines and exercises management review. Planning and operational oversight of IT stay with each center, however. As a result, planning is program-specific and optimized for many different functional applications rather than one integrated system.

Because of the need for communications, coordination, and technology transfer both internally and with contractors, the AIM Council and NASA central IT plan are concerned with creating an integrated information environment for agency-wide administrative support — electronic mail and conferencing, on-line administrative databases, electronic document and form creation, and automated program tracking. NASA has adopted a flexible system architecture for future networking and integration, changing user requirements, and changing technologies and missions.

NOAA. NOAA is a holding company, a composite of five line offices* gathered under a broad, sweeping mission. NOAA is much more information-intense than NASA, largely because of the dominance of the information based National Weather Service. Other NOAA agencies such as National Environmental Data and Information System (NESDIS) exchange and integrate environmental, oceans, and atmospheric information among the line agencies. NOAA provides unique, vital, and extensive information services, including raw weather data, charts and maps, forecasts, resource and geophysical models, and comprehensive environmental, atmospheric, and ocean databases. Its information collection spans the globe.

This holding company structure, with largely autonomous line offices, drives NOAA headquarters towards decentralized and unstructured planning. Administrative services at NOAA have been transferred to the Department of Commerce, removing one incentive for NOAA to do centralized planning for administrative IT.

On the other hand, National Weather Service has a highly structured, integrated planning process. Since much of NWS's information is a vital public service, accurate and reliable collection and delivery using forefront technology is a priority.

2. INCREMENTAL, CENTRALIZED, HIERARCHICAL, STRUCTURED, INTEGRATED, EFFICIENCY ORIENTED, ESTABLISHED TECHNOLOGY

EPA. EPA's mission is broad and its operations diffuse. It is organized around environmental media — air, land, water, waste. EPA is information-intense, managing many large databases, documenting regulation, and coordinating information collection and dissemination with state and local governments, public interest groups, trade associations and corporations, and other agencies.

Although EPA has strong regional offices and distinct divisions among the different media offices, IT planning tends to be centralized.

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*National Weather Service (NWS), National Environmental Satellite, Data and Information Service (NESDIS), National Marine Fisheries Service (NMFS), National Ocean Service (NOS), and Oceanic and Atmospheric Research (OAR).

and hierarchical. The directions come from above and the Information Management staff works to develop a consensus on these directions. Current diretions include reducing inefficiencies, improving state and local reporting, and enhancing enforcement by finding and tracking polluters.

The diversity of EPA IT applications has led to a concern with integrating systems and databases. Because of the large volume and varied nature of the information which flows through EPA, IT planning tends to concentrate on ensuring compatibility more than using forefront technology; hence the plans are based on an IBM system.

Department of Energy. DOE is familiar with IT since it uses supercomputers, microcomputers, inventory tracking, and extensive scientific monitoring technology in its laboratories. Since much of its mission involves R&D or nuclear installations, DOE emphasizes physical and hardware security and control of information flow. A significant exception is the Energy Information Administration, which has the central function of information dissemination within and outside the Department. Although DOE is akin to NASA or NOAA in its collection of nationally dispersed, R&D oriented centers, security concerns lead it to keep IT planning hierarchical and structured.

The DOE long-range plan is centralized, highly structured, and data-oriented. It is oriented towards hardware, inventory, and acquisitions. Planning authority and control are centralized, although the individual agencies of DOE do extensive operational IT planning which is included as part of the agency composite plan.

FBI. The FBI is highly centralized, though about half its personnel are in 59 field divisions. As an investigative agency, most of its information is managed for internal use and to a lesser extent related agencies. Procurement is centralized, reviewed by the Technical Services Division, which handles FBI IT planning. Security concerns have made IT planning highly structured and hierarchical, although line office perspectives are incorporated. The five-year strategic automation plan is incremental and oriented toward improved efficiency through matching and toward protecting system integrity.

GSA. GSA has been described as a management conglomerate. Its mission to provide central federal administrative, supplies and facility services puts it a position of fighting fires and solving problems rather than working towards a clear long-range goal. It has a decentralized planning and management style.

GSA does two types of IT planning. It does its own internal planning and it provides guidance to other agencies' IT planning. In terms of its internal planning, GSA took a centralized, structured approach to its five-year ADP Strategic Plan which was generated in 90 days. An administrative task force gathered information on the status of ADP and IT objectives. It then developed an agency-wide plan. The input of functional managers was solicited through questionnaires and review, but the planning was done primarily on the basis of top level directions. Functional managers were briefed on the task force's conclusions. Following its operating style, the IT plan took an incremental approach to improving existing functions through established technology.

NSF. NSF is a small, science and engineering oriented agency heavy with highly educated managers who are comfortable with technology. It has a stable, well-defined mission. Its information handling emphasizes administrative and statistical support of its primary mission to award and oversee research grants. NSF sends out about 300,000 letters a year to a clientele composed largely of researchers.

Heavy emphasis on office automation, a narrow mission centered around one large administrative database, and small size encourage a centralized, top down planning process at NSF. The long-range plan for information processing was conducted by a Management Information Systems Steering Committee (MISSC), selected and run by senior management. The plan is based on an unchanging resource, policy, and user environment. NSF plans see improvements in IT as an incremental enhancements in existing functions.

Social Security Administration. SSA is highly information intensive, with moderate information privacy concerns. The productivity and cost efficiency of an extraordinarily large volume of data transactions is of paramount importance. Its political visibility encourages centralized control and reinforces the need for system accountability, error reduction, and demonstrable systems effectiveness.

SSA's system orientation and interest in significant IT improvements was triggered by the crisis situation of its IT system. Its long-range IRM plan is titled, "From Survival to State of the Art." It is organized in three stages: 1) avert disaster; 2)move to modern data processing environment, and 3) test and certify the redesigned system. The themes of its IT plan are project continuity, use of reliable, proven state of the art systems, building on existing systems, and centralized IRM control.

3. LONG TERM, CENTRALIZED, INTEGRATED, SECURITY AND PRIVACY CONSCIOUS

Bureau of the Census. Information is the lifeblood of Census. Planning for the immense job of collecting, recording, editing, analyzing, and disseminating information from the 5 and 10 year censuses of people and economic activity overshadows all other concerns. Although Census has an extensive field workforce, the dominance of the central data collection and analysis mission makes centralized oversight and planning sensible. However, Census encourages and supports innovations and experiments to improve the way it does its job.

Confidentiality of information is essential to Census planning. All IT changes are scrutinized for their possible effect on the ability to protect the confidentiality upon which thier ability to collect information depends.

A role uniquely important to Census is wide dissemination of easily understandable information to public, government, and corporate users. This extreme variety and number of customers is important to Census IT planning.

FAA. FAA has a centralized planning and program management style and decentralized operations. As aviation becomes increasingly complex, IT-dependent, and critical in business and public planning, FAA has responded with a long-range, integrated systems approach to IT planning. Information processing is moving from decentralized to a centrally controlled, distributed environment for large scale national systems.

A task force carried out initial FAA long range IRM planning and laid out strategic goals. However, execution of the plan has not matched the vision. The plan was organized around existing functional and program area work groups, each of which generated incremental programs building on their existing needs. The process was highly structured with extensive top level involvement, but poorly integrated with agency resources.

IRS. Although its operations are decentralized, IRS maintains central policy, planning, and quality control. IRS has a stable, highly integrated, and information-intensive mission; its tax forms processing technology is more advanced than its administrative IT. To encourage taxpayer confidence and voluntary compliance, IRS planning and management stresses the integrity of its information handling and the protection of privacy. Taxpayer information is extensively processed, manipulated, sorted, coded, and checked, making efficiency and security of information handling critical.

The systems approach to IT planning matches the integrated nature of IRS operations, including returns processing, examinations, payments, and data analysis. IRS has a successful history of embracing new technologies to improve its overall mission performance, for instance the rapid adoption of optical character recognition. A strategy of full scale revision is driven by recognition of the opportunities offered by emerging technologies for greatly enhancing the efficiency and quality of IRS services.

4. LONG TERM, CENTRALIZED, PARTICIPATORY, AD HOC, INTEGRATED, EFFICIENCY ORIENTED, ESTABLISHED TECHNOLOGY

Department of Justice. DOJ information processing primarily supports decisionmaking, rather than actively gathering, processing, and disseminating information. IT planning, budget formulation, and procurement policy are highly centralized at DOJ, although execution is decentralized. In addition to the headquarters, DOJ encompasses many diverse, geographically dispersed, and relatively independent subsidiaries -- the FBI, Bureau of Prisons, the Immigration and Naturalization Service, and the Drug Enforcement Agency. However, these bureaus all share headquarters' IT emphasis on reference statistics and database management, which are congenial to centralized guidelines.

The senior Planning Task Group which met to develop a strategic IT plan took a long-term strategic, goal-oriented approach. They identified key factors shaping the future and organized a tactical planning subgroup to define projects, scehdules, priorities, and integration. They produced a strategic plan, identifying 25 major objectives, and a tactical plan which translated objectives into systems projects. The task force also produced Automated Information Systems Planning Methodology Guidelines for use by other divisions.

Department of State. With the latest generation of advances in international telecommunications, State has moved to "controlled decentralization." However, all operations remain tightly linked to central policy under top down oversight. With its far flung operations, each with different issues and needs, State has taken an informal, ad hoc approach to overall IT planning. Confidentiality is important because of national security and extensive international transfer of information.

Because of its sensitivity to information handling and its people orientation, State IT planning is structured around the flow of information rather than hardware specifications. International operations increase the importance of compatibility in IT planning. State has a highly mobile staff, which argues for planning around user-friendly, standardized IT. This was a dominant factor in early office automation; state went with uniform word processing equipment from a single supplier.

Consumer Products Safety Commission is a small agency, not particularly information- or communications-intensive. It emphasizes rulemaking rather than information handling. It maintains several databases and clearinghouses on product-related injuries and other subjects. CPSC has an annual operating plan but its IT needs and problems are too few to warrant a large-scale, formal IT planning effort. For instance, CPSC gathers some sensitive business information but the volume is too small to warrant encryption or technological innovation; the material is handled by courier.

Federal Communications Commission. Similar to CPSC, FCC is a small, high level decisionmaking and regulatory agency rather than a large data processing organization. Its concern is primarily with office automation. The current long-term system approach to IT planning is partly due to a history of haphazard, unintegrated automation. FCC's strategy is to leapfrog a generation of technology to create a fully integrated state of the art network. In its initial IRM planning, an ADP Steering Committee offered guidelines illustrated with a vision of the FCC office of the future rather than a detailed plan.

6. INCREMENTAL, DISTRIBUTED, INFORMAL, FRAGMENTED, EFFICIENCY BASED, ESTABLISHED TECHNOLOGY

Department of Agriculture. USDA is a highly decentralized agency, with 109,000 employees at more than 15,000 locations. There are already 10,000-15,000 microcomputers in the department. It has 33 disparate agencies at different stages of IRM. During USDA's long-range IRM planning cycle, each of these agencies prepared a plan. These were collated into a department-wide plan. USDA's planning goals are cohesion and flexibility; it was one of the agencies to move early into IT resource sharing across the department. However, the vast size and diversity of IT applications throughout USDA make an integrated systems approach unwieldy, and have tipped the balance in favor of a coordinating, incremental change-oriented planning style. This makes for a sometimes patchy approach; the department level IT planners do not systematically review all ongoing, operational activities.

Planning is done in an regular, overlapping 15 month cycle, coinciding with the budget cycle. The process is formalized, two-tier, and cyclic. The bulk of actual planning is done at the agency level, with the central Office of IRM providing central guidance, review, and approval.

Another reason for this planning style has been a traditional emphasis at USDA on management rather than technology. "Technological advances must take a back seat to management advances." USDA's ten major initiatives for Reform '88 are:

- Make administrative systems cheaper, less paper-intensive
- Develop departmental administrative systems
- Eliminate unnecessary administrative requirements
- Optimize delegations of administrative authority
- Increase use of automation technology
- Reduce the workforce in common support areas
- Ensure the most cost effective use of comunications technology
- Enhance productivity of and input from employees
- Review and adjust responsibilities for operational support services

Clearly management efficiency dominates USDA's IT planning.

Department of Commerce. Although large and diverse, including quasi-independent agencies such as National Bureau of Standards and NOAA, Commerce has a strong central grouping of core trade, business, and economic-related offices. The department has a tradition of central administrative oversight, balancing the geographic and functional diversity of its agency holdings. Department action on administrative IT has strongly pursued economic and resource efficiency with a nationwide quintuplet of centrally controlled administrative support centers. Mission-related IT emphasizes statistical analysis and database management, appropriate to a low technology and component compatibility approach to IT planning.

Department of the Interior. DOI is a holding company encompassing nine fairly independent bureaus, with the department's main role as central manager and reviewer. This structure has encouraged a fragmented approach to IT planning. DOI was one of the first to implement the IRM concept, when in January 1980 it established the interdisciplinary Office of IRM, which includes strategic planning.

DOI's long-range IRM planning approach is structured but decentralized. It has four levels of planning detail: goals, subplans, major products/functional plans, and tasks. The same system is applied at Department and bureau level. Each bureau develops its own functional plan. The department plan compiles these for comparison and to identify opportunities for resource sharing and joint information-related efforts. Department priorities are collapsing overlapping projects and integrating the management of administrative information handling. This central guidance has not replaced the traditional planning cycle at DOI. Generally, DOI has had a project and automated systems orientation rather than full systems integration.

Determinants of Agency Styles

Differences in agency styles of IT planning emerge from differences in the mission, organization, and history of agencies. Each agency has developed a management style, the equivalent of a corporate culture, and to be successful IT planning must fit that agency style. The determinants of agency IT planning styles include:

Importance of IT to mission: IT is important to all agencies. But for some agencies such as SSA, such technology is vital. Where IT is central, planning is likely to be centralized, integrated, and long term. Where IT is seen as merely office automation, planning is distributed, routine, and incremental.

Structure of the agency: Decentralized agencies tend to have IT plans that are collections of subunit plans. This is most clearly the case with the holding company agencies such as NOAA, USDA, and Interior.

Geographical organization: Widely dispersed agencies must pay more attention to security and reliability of communications and to compatibility of diverse systems than those agencies that are centrally located.

Personnel: Agencies with technically experienced staff tend to concentrate more on end user computing than do large centralized agencies with extensive clerical staffs.

Breadth of IT applications: Agencies with a single IT mission or application are likely to have centralized integrated plans while those with diverse information resources will tend to have distributed, fragmented planning processes.

Agency management and planning tradition: If an agency does does most of its management at the line office level, that is where IT planning will be done. On the other hand, where top management exerts strong central control, IT planning will be a top level management activity.

Leaders: The imprint of a forceful individual can override these other factors or it can galvanize them. For example, an SSA Commissioner made systems modernization his top priority and was responsible for moving the agency from crisis to some measure of planned change.

These are some of the more important factors shaping the styles of federal agencies' IT plans. The general theme is that IT planning follows the pattern of organization, management, and operation of the agency. Where information technology is critical to each of these, planning is important and effective. Where IT is seen as an adjunct, planning is routine, incremental, and superficial. While these factors shape the form and substance of IT plans, there are opportunities for improvement; these are discussed more in the next chapter.

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8. Ibid.

9. See OMB, Management of the United States Government - Fiscal Year 1986.

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CHAPTER VIII

REACHING THE DESIRABLE FUTURE IN FEDERAL INFORMATION TECHNOLOGY

Each of the three branches of government has its own difficulties in coming to grips with revolutionary change. Today information technology is one of the few areas widely recognized as pregnant with revolutionary change for the society and the economy. Yet the private sector and government, each with its own special reasons, turn away from dealing with the impending upheavals. Each lacks visions of what the new future could be like. In the absence of vision, the approach to new technology must be short term and incremental.

The purpose of this chapter is to probe the difficulties that government faces in dealing with the impending revolution in structure, function and organization driven by information technology. This chapter, drawing upon the scenarios in the previous chapters, deals with three points:

- Factors helping and hindering federal management of information technology leading towards a desired future;
- The gap between planning and implementation;
- Potential Congressional activities.

Factors Helping and Hindering Agencies in Reaching a Desirable Information Technology Future

The factors fall in the obvious categories of technology, organization, and politics. Each factor is tied to the others so that any isolation for purposes of discussion must falsify the complexity of these interactions.

Technological Factors. Information technology is evolving so rapidly in its capabilities and declining so steadily in its cost that long-range planning is difficult. Ideally, an agency would like to purchase well established, stable, well tested and proven technology, durable over a long period. Information technology fails all of those criteria because the capabilities are increasing so rapidly that the planning and procurement cycle often exceeds the time to the next generation of technological capabilities. Recognizing this creates the difficulty of pushing the agency to purchasing on speculation -- to purchase technology and capabilities that do not yet exist. Doing this, however sensible it may be, tends to stress even the boldest bureaucrat.

Not only are the individual computer and telecommunication devices rapidly evolving, but the technological systems themselves are changing just as fast. No federal agency operating on a nationwide basis with regional and local facilities can with confidence say what its needs or the capabilities available to it will be five to ten years hence for communciation among those facilities. New modes of communication, the AT&T divestiture, the entry of new competitors and the competition among and between various technological networks adds a new level of complexity to planning.

In the absence of a strategic plan, that is a plan which relates the goals and missions of the organization to current actions, long-range planning tends to become merely the incremental accumulation of technological devices, basically to substitute for technologies now in hand or to augment technologies and functions now being performed.

Organizational and Political Factors. The most significant organizational factor foreshortening information technology planning is the perpetual uncertainties and challenges of budget. A well thought out systematic five to ten year plan cannot be based on roller coaster budgets shaped by erratic executive and legislative action. Budgetary uncertainty drives the system to incremental, relatively sure and safe or at least damage-limiting plans.

The great dark spot, the black hole of the present federal system, without question is procurement. In our own studies of the future of several federal organizations the two areas which continually come up as the least satisfactory elements for the total federal system are procurement and personnel.

The Congress, in attempting to achieve greater and greater degrees of equity, fairness, competitiveness and cost control, has created a bureaucratic monster which has a life, a reality, and a vitality all of its own in each federal agency contracts office. At only the slightest risk of hyperbole contracts and procurements exist as an independent entity in the agencies, independent of the goals, missions, time schedules or control of the organization. Safety, and immunity from serious Congressional challenge, dominate the contract office mentality. The result is over-proceduralization, over-specification, incredible delay, foolish competition in contracting and planning, and fundamental inattention to the purpose of the organization.

The delays built into procurement work with the technological factors above to assure even more rapid obsolescence of new systems than normal practices would suggest. Furthermore, there is a tendency within procurement to go to high degrees of technical specification rather than to performance specification. The result is the procurement process itself grinds to a halt in its inability to define detailed specs which are inappropriate in a rapidly evolving and competitive technological world. Detailed technological specs carefully defined may be appropriate in building and construction but are certainly not appropriate for telecommunication and computers.

While procurement delays have undoubtedly from time to time been used as pretext and excuses for other failures in the organizational system, a fundamental fact permeating all of government is that procurement is desparately in need of a comprehensive Congressional overhaul. We see no hope in putting information technology procurement on a sounder footing until the larger procurement mess is addressed.

Separate and distinct from the above is the drive stimulated in part by Congressional interest and in part by OMB oversight, to aggregate telematics procurement. This creates new visibility for telematics in the budget. One of the undoubted consequences of new visibility will be to drive toward budget cutting which again promotes the worst side of the organizational practices noted above, deeply limiting useful planning. In many organizations information technology should still be at the experimental stage with extensive trial and error learning and a high degree of centralization and autonomy. While no general rule could be laid down, it is clear that for many organizations efficiency should now be deferred for the sake of effectiveness in learning and long-term improvements in systems design, development, and procurement.

Experimentation should be a central feature of the procurement of major new information technology. To the best of our knowledge it is virtually an unknown in the present federal executive system. We know of no large scale experiment with telematics technology to define choices, to explore and monitor consequences, and to create planning feedback.

The monitoring of consequences of telematics technology is generally ignored in the present syste. Organizational conservativism and fear drive toward the severe suppression of the explicit acknowledgment of many of the most significant consequences of information technology such as labor force cutbacks, shifting responsibilities, reorganization and elimination of branch offices and field offices. Much of this denial is due not to ignorance but to fear of having to cope with the erratic and unforseeable political consequences of acknowledging bad news or change.

Telematics procurement goes relatively well and straightforwardly in those organizations which are scientifically based, or those which perform a function in which the need for advanced information technology is beyond dipute. However, this is not a surefire guide, as the recent years of experience with SSA show. That organization passed through a period of near disaster and has only in the last couple of years emerged into a new era of effective high technology. Two clear lessons come out of that. First, that one cannot rely upon the promises and assurances of managers alone that things are going well. An indictment of previous practices at SSA which is so frank, forthright and relentless as to be almost unique in the annals of the federal government will be found in the SSA's "System's Modernization Plan: From Survival to State of the Art." The second lesson is that new top management often can facilitate a required change because the continuing leadership often gets caught up in an ever tightening web of advertised capabilities, competence, and complacency and so finds it increasingly difficult to acknowledge problems.

Risk taking is intrinsic to the handling of any transformational new technology. But there are few or no safeguards for risk taking in the present federal system. The sense that errors will occur and are inevitable seems to make no positive impression on the press, and more significantly, no positive impression on the Congress. Certain realities are beyond technical or scientific dispute. Among these are:

- Breaches of security and privacy will and must occur;
- Technological systems will fall short of promise and falter;
- There will be thefts and crime;
- Systems will fail due to inevitable unanticipated factors in the natural or manmade environment, changes in roles or missions, disruption or sabotage.

The single greatest difficulty that the Congress has in coping with these intrinsic facts of technology in bureaucratic life is to recognize that these errors are inevitable and to not treat every single episode, as a national crisis demanding extensive hearings, strident accusations, scapegoating, punishment and the immediate imposition of new controls.

Essential to a healthy oversight process is the recognition that the above failures inevitably will occcur. A certain structured forbearance for some low level of these events must be built in to avoid a crisis atmosphere and to promote risk taking, experimentation, and positive planning and development on the part of the agencies. Healthy oversight is ideological and political and does not lend itself to formula treatment but rather calls for a resetting of Congressional attitudes. The temptation to take a cheap shot must in some sense be constrained if planning is to work.

An inevitable question is, What can the agencies do? The unfortunate answer is nearly nothing in the absence of leadership. Leadership is not a factor that can be called up from the innards of an agency. It is even difficult to recognize in these processes of oversight and approval of agency top managers. In the absence of leadership, the most that one can hope for is that the individual agencies will bumble along the best they can within the above constraints. In the absence of effective Congressional or Presidential action, to legitimate visions of the future, experimentation and risk taking, there is little that the agencies can do to plan better.

The Gap Between Planning and Implementation

There is a relatively small gap between planning and implementation because effectively most of the planning in information technology in the federal government today is short-term and incremental, guaranteeing that there will be relatively little gap between planning and implementation. In those organizations committed to large scale science-based or national security based investments, there is relatively little problem in long-term planning.

Longer range information technology planning, is particularly difficult in those organizations which are political hotspots and the continual focus of oversight and challenge as the perennial targets of political probing and questioning.

Comparisons between corporate and public planning have little or no merit, since the central feature absent in government and always present in the corporation is the bottom line, the economic payoff, or long-term economic viability. For the corporation payoff is a permanent standard, good or bad, with which to evaluate long- or short-term action. Planning and implementation in the federal government is complicated by the absence of a fixed universal standard of performance. But there cannot be such a standard.

An interesting way to highlight the pressure for the short term and the consequent absence of a gap between planning and implementation is the failure of the two organizations in government with management in their titles, the Office of Management and Budget and the Office of Personnel Management, to separately or together develop plans for the institutionalization of telecommunications and computer technology and the management of its inevitable long-term consequences.

Implications for Congressional Action

The preceding sections and earlier chapter described the general characteristics of information technology planning in government and their manifestation in different agency styles. These characteristics and styles of information technology planning are not set in concrete. They are the ways the agencies have resolved the tensions inherent in telematics planning. These tradeoffs include:

- Central management vs. distributed responsibility: Giving the agencies too much autonomy in managing information resources can lead to waste, delay, and slower development. On the other hand, centralized planning by OMB or GSA for all agencies' telematics would not reflect the diversity of demands agencies place on these technologies. The tendency is to give the agencies more rather than less autonomy while reviewing plans to ensure efficient and effective government-wide use of information technologies.
- Projected capabilities vs. proven, reliable, low cost: Some agencies claim extensive savings and improvements from the introduction of new information technologies. However, they often buy proven, reliable, often obsolete systems which do not provide the savings or the improvements claimed.
- Efficiency vs confidentiality: When OMB calls for more sharing of data, agencies collecting sensitive personal or corporate data such as Census and IRS argue that doing so threatens the confidentiality upon which the success of their missions rests. On the other hand, government is looking to reduce the reporting burden on citizens.
- System replacement vs. incremental upgrade: In its draft circular OMB makes it clear that upgrades should be replaced by more systematic, strategic overhauls of information systems. Yet all but the most desperate agencies take incremental steps.
- ADP focus vs. user focus: The growth of end user computing in the federal government is changing the structure and functioning of many information systems. Agency IRM staff

look to large, centralized, batch processing when the wave of the future is small scale, distributed processing. Hence the conflict over user friendly and complex, powerful, hard to use hardware and software.

- Specific goals vs. system integrity: In some cases outside demands force the agency to compromise the overall integrity of the information system. For example, requiring the IRS to use tax returns to assist in tracking down delinquent student loan payers jeopardizes the voluntary compliance upon which the tax collection system depends.

If Congress wishes to improve government information technology planning, it needs to understand the limits and opportunities implied by these tradeoffs. A centralized, state of the art, full scale revision focused solely on improving the efficiency of large scale batch processing will not work in the current environment; neither will a completely decentralized, incremental approach relying only on proven off-the-shelf technology and directed solely at end users. The needs of the government are too diverse to warrant either of these extremes. The most appropriate approach is somewhere in the middle ground. In seeking to define that middle ground, Congress should address the following nine trouble spots in information technology planning:

1. **The crisis atmosphere:** Episodic funds for information technology, erratic, arbitrary and chilling reviews by OMB and the Congress, and the lack of management continuity create a tendency to let information system problems build into crises in which Congress has no option except to provide resources.
2. **The special needs of information technology planning:** Much information technology planning involves general planning tasks such as deciding on the mission, looking to the future, involving interested parties, setting strategies, and identifying action options. However, there needs to be more attention to the special needs of information technology planning — reducing uncertainty, improving the technological base,

countering the reliance on experts, and looking to the breadth of long-range effects on the agency.

3. Security: Breaches of security must happen. The key question is whether the Congress and the agencies are going to respond in a reasonable and systematic fashion. The current tendency is to treat security as a peripheral issue largely handled through technical safeguards. More attention to institutional innovations to protect security is needed.
4. **The efficiency/productivity craze:** Efficiency and productivity are the metrics by which progress in information technology use are measured. However, other functions such as responsiveness to public needs, providing access to public information, creating a good place to work, and protecting the public welfare may conflict with the pressure to cut costs. Since these other functions are difficult to measure they will have a hard time holding their own against dollars and cents.
5. **Civil liberties and privacy not central:** Civil liberties, privacy, and confidentiality are not important to all agencies' information technology planning. For example, the Park Service faces few privacy and civil liberties issues. However agencies handling sensitive personal and corporate data can in their desire to cut costs, increase efficiency, and improve effectiveness overlook the need to safeguard privacy. At Census, confidentiality is a key baseline concern in planning. At SSA, the drive for efficiency, especially in the search for overpayments, diminishes concern for the protection of individual records.
6. **Threats to confidentiality of data on civil servants:** Growing concern with the productivity of federal workers is leading to unprecedented data collection on the activities of these workers. While the use of this data will improve government operations, possible abuses may raise questions for the Congress on the privacy rights of civil servants.

7. **The procurement mess:** The problems of information technology management cannot be separated from the overall mess in federal procurement. The bureaucratic inertia and proceduralism of federal ADP procurement means that the time to get a request through procurement is approaching the turnover time in many information technologies (six months to a year). Without procurement reform, even the best laid plans for information technology will go awry.
8. **The turnover in information technology managers:** If the federal agencies are to move beyond a crisis driven, incremental, narrow, fragmented approach to information planning a prerequisite is stable leadership. Management turnover is a fact of life in the federal government. However, there may be ways to insulate the information technology planning process from the worst effects of this turnover.
9. **Indifference to the long range effects of information technology:** New types of employees, new relationships with field offices and with state and local governments, and new missions will come from improving information resources management capabilities. Yet there is little recognition of the wide range of beneficial or adverse effects (labor displacement, new vulnerabilities, threats to privacy) these technologies could have on government.

What can Congress do to deal with these trouble spots? Information technology planning will remain agency based, incremental, and short term, and idiosyncratic regardless of what the Congress does. Efforts to delegate centralized powers beyond those already held but not always exercised by OMB, GSA, or NBS will not be effective. Within that general context, Congressional actions could include:

Legislation: Laying on more mandates, requirements, or sanctions will be the death of progress in information technology planning. The planning infrastructure is in place; what is needed is more legislative oversight on how agencies are meeting the intent of the Brooks Act and the Federal Paperwork Reduction Act of 1980.

The only imminent legislative need is a complete revamping of the procurement system. This would accomplish more than any tinkering with information technology planning processes.

Oversight: Reporting responsiblities such as those envisioned in our hypothetical Citizens Security Act would provide more guidance to the agencies about the nature and intent of existing Congressional mandates. This hypothetical legislation requires the agencies to assess and report regularly on the impact of information technologies on their mission, structure, function, organization, and effectiveness. Within such reports and related hearings Congressional committees could ask OMB, GSA and the individual agencies about:

- civil liberties protections
- security measure development, test, and evaluation
- agency innovations in managing information technologies
- public access to agency information
- the uses of information about civil servants
- the range of alternatives considered in their planning
- forecasting assumptions and their bases
- information technology crises in the making
- other issues relating to information technology management.

In looking into the security area, the Congress needs to avoid overplaying and dramatizing the inevitable security breaches. Instead it could prepare or have GSA and NBS prepare guidance for the agencies in dealing with the aftermath of such events.

Investigations: Congress could support several investigations which could further the course of information technology planning in the federal agencies. These studies could include:

- the unique features of federal information technology use
- lessons from private sector planning
- the effect of the procurement system on information technology use in federal agencies
- information technology effects on the federal workforce
- new government missions coming from information technology

- the effect of new or revised government missions on information technology use in government
- the integration of federal with state and local systems.

Congress is the only body with a strong interest in understanding the broad range of effects of information on the government as a whole.

Allocation of resources: The primary thrust of Congressional action in this area should be to put the acquisition of information technology on a different footing than normal budget cycles. Agencies need stable, long-term funds and flexibility in allocating those funds if they are to respond effectively to the changing technological marketplace. With appropriate controls, Congress could provide the money and the latitude. In addition to making agencies more effective such a strategy would separate out consideration of information technology in budget hearings. This would give great impetus to effective information technology planning in the agencies. It would also drive the central agencies more toward an advisory, facilitative role.

Other functions: Congress could also stabilize the turnover in information technology management in the agencies. For example, Congress could require that all senior IRM officials be senior civil servants. It could also look for information resources management experience in the candidates for administrative and management appointments.

Congress can have its greatest impact by defusing the crisis atmosphere of much information technology planning and promoting a broader attention in such planning to the needs and effects of these technologies. Also, by straightening out the procurement mess, Congress can help ensure the implementation of these improved plans.

APPENDIX A

Federal Government Information Technology

List of Contract Awards - US 84-10

US 84-10/1	Technology Description and Forecast J.F. Coates, Inc., Washington, D.C. OTA Liaison - Jim Dray
US 84-10/2	Comparative Review of Information Technology Management Practices in State Governments Institute of Information Management, Technology and Policy, University of South Carolina, Columbia, S.C. (Don Marchand) OTA Liaison - Fred Wood
US 84-10/3 and 10/4	Federal Computer and Telecommunications Security Federal Computer and Telecommunications Reliability Data Security Systems, Inc., Natick, MA. (Sanford Sherizen) OTA Liaison - Jim Dray
US 84-10/5	Federal Agency Profiles The KBL Group, Inc., Silver Spring, MD. (Karen Levitan) OTA Liaisons - Priscilla Regan/Jean Smith
US 84-10/6	State/Local Use of Information Technology in Administrative Decisionmaking Irvine Research Corporation, Irvine, CA. (Kenneth Kraemer, John King) OTA Liaison - Fred Wood
US 84-10/7	Administrative Decisionmaking - Comparative Policies No award.

US 84-10/8	Data Protection and Privacy - State and Local Experience Privacy Journal, Washington, D.C. (Robert Ellis Smith) OTA Liaison - Priscilla Regan
US 84-10/9	Data Protection and Privacy - Comparative Policies The University of Western Ontario (David H. Flaherty) OTA Liaison - Priscilla Regan
US 84-10/10 and 10/13	Civil Liberties - New Technologies and Existing Laws Survellance: Technology Jane Yurow Associates, Bethesda, MD. OTA Liaisons - Priscilla Regan/Jim Dray
US 84-10/11	Public Opinion and Government Information Technology University of Southern California (William Dutton, Robert Meadow) OTA Liaison - Priscilla Regan
US 84-10/12	Surveillance: Historical/Policy Review Herman Schwartz, American University, Washington, D.C. OTA Liaison - Jim Dray
US 84-10/14	Government Provision of Public Information Information Management Consultant Services, Inc., Norman, OK (Charles McClure, Peter Hernon) OTA Liaison - Jean Smith
US 84-10/15	Federal Agency Use of Analytical Tools Decision Science Consortium, Falls Church, VA. (Jacob Ulvila) OTA Liaison - Fred Wood

US 84-10/16	Congressional Applications of Information Technology Congressional Data Associates, Annapolis, MD. (Stephen Frantzich) OTA Liaison - Fred Wood
US 84-10/17	State Legislature Use of Information Technology in Oversight University of Nebraska, Lincoln, (Robert D. Miewald) OTA Liaison - Priscilla Regan

APPENDIX B

AGENCY WORKSHOP ATTENDEES

Listed below are the agency representatives who participated in the project workshops. The principal contact in each agency is noted with an asterisk. These people were instrumental in bringing together knowledgeable and diverse workshop participants from their agencies.

NOAA Workshop Attendees

Bill Braxton	
Margaret Courain	
Tom Maginnis*	
Arthur Altenburg	National Telecommunications and Information Administration
Newton Page	
Marty Wagner	Office of Management and Budget

In addition, Orn Tobey and Alan Thomas at NOAA helped with comments.

Census Workshop Attendees

Robert Bair	Special Adviser to the Assistant Director for International Programs
Richard Blass	Assistant Division Chief for Research and Methodology, Field Division
Lawrence Cox	Office of Associate Director for Statistical Standards and Methodology
Evan Davey	Assistant Division Chief for Special Surveys, Demographic Surveys Division
Warren Davis	Organization and Management Systems Division
Dwight Dean	Project Director for CATI, Field Division
Michael Garland*	Data User Services Division
Heyward Glisson	Special Assistant to the Assistant Director for Economic Surveys
Stanley Hyman	Special Assistant to the Assistant Director for Economic and Agriculture Censuses
Richard Maier	Office of Assistant Director for ADP
June Middleton	Decennial Operations Division
Silla Tomasi	Assistant Division Chief for Operations, Geography Division
Susan Trento	Congressional Liaison Specialist

SSA Workshop Attendees

Workshop attendees chose not to be acknowledged or associated with this report.

IRS Workshop Attendees

Carmen Genotti
Charles Gibb
Bill Miller
Jim Pavanti
Ron Renrode
Tom Quinn
Tom Tiffany*
Bill Uruni
Paul Wanslow

EPA Workshop Attendees

Mike Conlon	Office of Water Regulation and Standards
Alice Fitzgerald	Facilities and Support Services Division
Donald Fulford	OARM
Stormy Friday	Facilities and Support Services Division
Marguerite Hall	Office of Solid Waste
Sherron Hiemstra*	Information Management and Services Division
Richard Johnson	Information Management Division
Tony Jover	Program Systems Division
Robert Lewis	Information Management Division
Avrum Marks	Office of Drinking Water
Michael McNeill	Office of Solid Waste and Emergency Response
Jerry Miller	Washington Information Center
Edmund Notzon	Office of Water
Arthur Pergam	Information Management and Services Division
Larry Reed	Office of Water Enforcement and Permits
Dwight Rogers	Facilities and Support Services Division
Bruce Rothrock	Office of Enforcement and Compliance Monitoring
Cindy Sayers	Facilities and Support Services Division
Jack Sweeney	Administrative Services Division
Charles Tobin	Program Systems Division
Daniel Yurman	Office of Solid Waste and Emergency Response

In addition, Ed Hanley and Rick Johnson assisted.

OTA

One or several project staff persons from OTA attended the agency workshops:

Jim Dray
Pris Regan
Jean Smith
Marjorie Blumenthal

APPENDIX C

CENSUS BUREAU PROGRAMS AND PRODUCTS

Statistical program	Censuses			Surveys, estimates, and projections			
	Examples of data	Publication areas	Frequency	Series	Examples of data	Publication areas	Frequency
POPULATION	Age, sex, race, ethnicity, marital status, household relationship, education, place of birth, year of immigration, language, residence and activity 5 years ago, disability, children ever born, marital history, employment status, hours worked in previous week, transportation to work, job activity, industry and occupation, income	U.S., regions, divisions, States, SMSA's, counties, places, urbanized areas, minor civil divisions (MCD's), census tracts, blocks	Years ending in "0"	Population Characteristics, P-20	School enrollment, fertility, mobility	U.S.	Annual
				Population Estimates and Projections, P-25	Population	U.S.	Monthly
					Age, sex, race	U.S	Annual
					Population, income	Counties, specified places	Annual
				Special Studies, P-23	Youth, aging, female family heads	U.S.	Irregular
				Federal-State Cooperative Program for Population Estimates, P-26	Births, deaths, net migration, population estimates	Counties, metropolitan areas	Annual
				Farm Population, P-27	Age, race, employment characteristics	U.S.	Annual
				Special Censuses, P-28	Age, sex, race	Counties, places	Contract
				Consumer Income, P-60	Money income, low-income households	U.S.	Annual
				Collected for other Federal agencies	Labor force characteristics, health, crime, criminal justice systems and correctional institutions, longitudinal studies of socioeconomic changes, voting, education, income, government tax effort	U.S., States, large cities, governmental units	Periodic
HOUSING	Rooms, plumbing facilities, tenure, value, contract rent, telephone, vacancy status, heating equipment, water sources, fuels, automobiles, shelter costs for homeowners	Same as above	Years ending in "0"	Components of Inventory Change	New construction, conversions, mergers, demolitions, recent movers' characteristics	U.S., regions, 15 SMSA's	Years ending in "0"
				Residential Finance	Financing of non-farm homes; characteristics of mortgages, properties, owners	U.S., regions, inside and outside SMSA's	Years ending in "0"
				Housing Vacancy Survey, H-111	Vacancy rates, characteristics of vacant units	U.S., regions, inside and outside SMSA's	Quarterly, annual
				Market Absorption of Apartments, H-130	Absorption rates by size, rent, facilities	U.S.	Quarterly, annual
				Annual Housing Survey, H-150	Characteristics of housing (general, financial, quality), recent movers	U.S., regions, inside and outside SMSA's, urban and rural	Annual
				Annual Housing Survey, H-170	As above	60 selected SMSA's, with central cities and suburbs	Annual
AGRICULTURE	Acreage, land use and value, equipment, production, sales, expenses, debts, operator characteristics, agricultural services	U.S., regions, divisions, States, counties	1974, 1978, then years ending in "2" and "7"	Farm Population P-27	Age, race, employment characteristics	U.S.	Annual
				Cotton Ginnings, A-10	Ginnings	States	Seasonal
				Cotton Ginnings, A-20	Ginnings	Counties	7 per yr.
	Irrigation, drainage, horticulture, farm finance	States	10 years	Cotton Ginnings	Ginnings	U.S.	Annual
CONSTRUCTION INDUSTRIES	Employees, payrolls, receipts, expenditures, assets, depreciation, project location and ownership	U.S., regions, divisions, States	Years ending in "2" and "7"	Housing Starts, C-20	Ownership, type of construction, permits, mobile home shipments, apartment building characteristics	U.S., regions, inside and outside SMSA's	Monthly
				New Residential Construction, C-21	Estimated number of units	20 SMSA's	Quarterly
				Housing Completions, C-22	No. of units	U.S., regions, metropolitan/ nonmetropolitan	Monthly
				New One-Family Homes Sold and For Sale, C-25	Sales	U.S	Monthly
					Financing	U.S.	Quarterly
				Characteristics of New Housing, C-25	Physical and financial characteristics	U.S., regions, inside and outside SMSA's	Annual
				Price Index of New One-Family Houses Sold, C-27	Changes in sales prices by physical characteristics	U.S.	Quarterly
						Regions	Annual
				Value of New Construction Put in Place, C-30	Private and public buildings, utilities, nonbuilding construction, residential alterations	U.S	Monthly

CENSUS BUREAU PROGRAMS AND PRODUCTS—Continued

Statistical program	Censuses			Surveys, estimates, and projections			
	Examples of data	Publication areas	Frequency	Series	Examples of data	Publication areas	Frequency
CONSTRUCTION INDUSTRIES (Con.)				Housing Authorized by Building Permits and Public Contracts, C-40	Excludes hotels, motels institutions	U.S., regions, divisions SMSA's, places	Monthly, annual
				Housing Units Authorized for Demolition in Permit-Issuing Places, C-45	Demolition, new construction	U.S., regions, divisions, SMSA's, selected cities	Annual
				Residential Alterations and Repairs, C-50	Expenditures	U.S.	Quarterly
					Expenditures by type of construction, other characteristics	U.S.	Annual
RETAIL TRADE	Kind of business, sales, payroll, organization, employment, size, specialized data	U.S., States, SMSA's, counties, places, selected MCD's, CBD's, MRC's	Year ending in "2" and "7"	Monthly Retail Trade, BR	Estimates of sales and receivables	U.S., regions, divisions; selected States, large SMSA's, and cities	Monthly
					Summary	Same as above	Annual
				Monthly Department Store Sales in Selected Areas, BD	Comparative sales by month and year	200 areas	Monthly
				Advance Monthly Retail Sales, BR-11	Trend analyses	U.S., selected SMSA's, and cities	Monthly
WHOLESALE TRADE	Kind of business, sales, payroll, employment, organization, size, expenses, inventories, specialized data	U.S., States, SMSA's, counties, selected places	Years ending in "2" and "7"	Monthly Wholesale Trade, BW	Sales, inventories	U.S., divisions	Monthly
				Canned Food: Stock, Pack, Shipments, B1	Comparative data	U.S.	5 times a year
				Green Coffee: Inventories, Imports, Roastings, BG-41	Data for roasters, importers, and dealers	U.S.	Quarterly
SERVICE INDUSTRIES	Receipts or revenue, payroll, expenses, employment, organization, specialized data	U.S., States, SMSA's, counties, cities	Years ending in "2" and "7"	Monthly Selected Service Receipts, BS	Comparative receipts	U.S.	Monthly
TRANSPORTATION	The Census of Transportation consists of four surveys			National Travel Survey	Volume, characteristics of travel and travelers, destinations, accommodations	U.S., regions, selected States and foreign areas	Years ending in "2" and "7"
				Truck Inventory and Use Survey	Characteristics, use, fleet size, area of operation, products, mileage	U.S., divisions, States	
				Commodity Transportation Survey	Manufacturers' intercity shipments	States	
				Motor Carrier Survey	Public carriers not subject to Federal regulation	U.S., States	
				Annual Housing Survey, H-150	Transportation to work, travel time, distance	U.S., regions, selected SMSA's	Annual
MANUFACTURES	Employment, hours, payroll, inventories, assets, expenditures, costs, contract work, product shipments, selected characteristics	U.S., regions, divisions, States, SMSA's, counties, cities	Years ending in "2" and "7"	Annual Survey of Manufactures	Same as census, except product class shipments	U.S., States, SMSA's, large industrial counties, selected cities	Annual
				Current Industrial Reports (a series of more than 100 separate reports, by subject)	Detailed commodity data, pollution abatement, plant capacity, research and development	U.S., some for States, SMSA's	Annual, quarterly, monthly
					Monthly shipments, inventories and orders	U.S.	Monthly
MINERAL INDUSTRIES	Employment, hours, payroll, expenses, capital expenditures, energy consumption, assets, organization, selected characteristics	U.S., regions, States	Years ending in "2" and "7"	Annual Survey of Oil and Gas	Field exploration, development, production	U.S., on and off shore	Annual
GOVERNMENTS	Organization, taxable property values, assessment-sales ratios, tax rates, employment, labor-management relations, payrolls, revenues, expenditures	U.S., States, counties, places, MCD's, school and special districts	Years ending in "2" and "7"	Government Employment, GE	Comparative employment and payroll	U.S., States, counties, places, special districts	Annual
				Government Finance, GF	Tax collections, finances	Same as above	Annual
				Finances of Selected Public Employee Retirement Systems, GR	Assets, receipts, benefits, withdrawal payments	100 major State and local systems	Quarterly
	Popularly elected officials	Same as above	Years ending in "7"	Quarterly Summary of State and Local Tax Revenue, GT	Collection by type of tax and level of government	States, selected SMSA's, counties, local areas	Quarterly
				State and Local Government Special Studies, GSS	Labor-management relations, criminal justice expenditures, property values	Varies	Periodic

CENSUS BUREAU PROGRAMS AND PUBLICATIONS

Statistical program	Sources	Surveys or reports			
		Series	Examples of data	Publication areas	Frequency
FOREIGN TRADE	Customs declarations, lading documents	Summary, detailed, and annual reports on imports and exports	Imports, exports, bunker fuels, vessel entrances and clearances, means of transportation, imported cotton manufactures, trade with Puerto Rico and U.S. possessions	U.S., world areas	Monthly and annual
GENERAL ECONOMIC	Various economic censuses	Minority-Owned Business Enterprises, MB	Basic economic data for Black, Spanish-origin, Asian American, American Indian, other minorities	U.S., divisions, States SMSA's, counties, and cities with 100 or more minority firms	Years ending in "2" and "7"
		Women-Owned Businesses, WB	Basic economic data	U.S., divisions, States, counties, SMSA's, cities	
		Enterprise Statistics, ES	Establishment-company relationships, centralized management and support services	U.S., selected areas	
	Annual surveys and administrative records	County Business Patterns, CBP	Employment, size of establishment, payrolls	U.S., selected areas	Annual
INTERNATIONAL RESEARCH	Foreign censuses, surveys, estimates and projections.	Research Documents, RD World Population, WP Country Demographic Profiles DP Family Planning Profiles, FP	Estimates and projections	Foreign countries	Periodic
		International Population Statistics Reports, P-90; International Population Reports, P-91	Population and labor force estimates, analysis, and bibliography	Foreign countries	Periodic
		International Population Reports, P-95	Population, labor force, wages, statistical systems, economic subjects		
DEMOGRAPHIC AND ECONOMIC ANALYSIS	Various U.S. and foreign censuses and surveys	Social Indicators	Health, education, housing, population, income, crime, etc.	U.S.	Periodic
		Agreed Basic Statistics	Population estimates and projections	Foreign countries	Periodic
		Foreign Economic Reports	Input-output and gross value data, analysis of economic subjects		
GEOGRAPHIC	U.S. demographic and economic censuses	Maps, GE-50	Socioeconomic characteristics (race, income, education, etc.)	Counties	Periodic
		Maps, GE-70	Urban/rural population distribution	U.S.	Periodic
			Older Americans, heating fuel	Counties	
		Urban Atlas, GE-80	Socioeconomic characteristics	Selected SMSA's by census tract	Periodic
		Congressional District Atlas	Boundaries and indexes, maps	Congressional districts	Each Congress

APPENDIX D

CENSUS MICROCOMPUTER INFORMATION CENTER

-BULLETIN-

Call For Articles

Have you something to say about microcomputers or their use? There are now over 300 microcomputers within this organization. Just what are all of you doing with this stuff, anyway? Playing Space Invaders???

Maybe you've found a bug in your new software package or an innovative way to do something that "couldn't be done". Why not share it? We would all love to hear about it. No, Honest!!! There are alot of isolated packets of microcomputer experience within the Bureau. It's better for all of us when the information circulates. Give us a call, or better yet, why not stop by and tell us how microcomputers are being incorporated into your office. Help us to help you!

dBASE III Update

The Census Microcomputer Information Center has available for use in the Center a copy of "dBASE III version 1.00 Product Usage Report" dated September 4, 1984 from Ashton-Tate Software Support Center. This report presents numerous problems (bugs) encountered using dBASE III.

Spreadsheet Analysis: Design and Application

The Census Microcomputer Information Center is sponsoring a seminar titled "Spreadsheet Analysis, Design and Application" as part of their ongoing "train the user" program. This seminar will include:

- Spreadsheet history
- The new integrated packages
- Selecting your spreadsheet software
- Designing your spreadsheet
- Documenting your spreadsheet
- Memory management
- and more!!!

For further information, please contac Pam Smith on 763-4494. There are a maximum of sixty (60) seats available.

Product Announcement #33

FRAMEWORK

and

dBASE III

Wednesday October 10, 1984

Technology Services, Inc. will presen a demonstration of both packages all day in the Census Microcomputer Infomation Center, Room 1065, FOB-3.